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Air Traffic Control

THAT radio navigation aids in Britain, which are an essential element in the control system, are in many instances out of date or inadequate to meet the growing volume of air traffic is the view expressed by the writer of a feature article in this issue (pages 271-274).

Similar shortcomings in the American system have caused grave concern and a vast programme for the provision of surveillance radar to cover the whole U.S. airspace is under way. Despite severe design-difficulties collision-warning devices are being demanded (as recorded on page 289) and the use of new equipment such as control-problem computers is being recommended to facilitate the calculations at present made by human controllers.

One bright fact emerges. The Decca Navigator and Flight Log have proved their performance in airline service as precision navigation aids; and this is officially recognized by reductions in separation requirements and provision of special Decca reporting points around London. Dectra promises an even greater improvement in the critical Atlantic navigation situation.

But two people should at all times know the exact position of an aircraft, the pilot and the controller. If only the pilot has this knowledge, then the control problem becomes one of communications. This is particularly so over the Atlantic, where communications are notoriously poor by reason of atmospheric interference. The communications situation is technically complicated and bedevilled by a shortage of frequencies. In solving these problems the important developments will be H.F. communications radios with well over 22,000 channels, single-sideband operation, airborne radio teleprinters and systems, the details of which are as yet unrevealed. In the preparation of such devices our electronics industry is certainly not lagging behind those of the rest of the world, but security regulations and a natural unwillingness to talk about new theories before they have been developed and proved keeps British developments out of the headlines. In America the reverse is often the case; an instance of prematurely raised hopes—for a proximity-warning indicator—is reported on page 289.

Ram Attack

SO much has been said about manned fighters and unmanned missiles that an interesting, and potentially important, fact has generally been overlooked —that the fighter itself can function as a guided missile. It is recorded that there were several occasions in the late war when Soviet pilots resorted to ramming their adversaries; and it is known, too, that ramming tactics have been discussed in recent Soviet military publications. "All other fighter tactics failing," runs an article in one of these, "the Soviet pilot, by his military oath, must use the ram attack"; and the Russians consider that ramming tactics are entirely feasible with today's military aircraft.

An official U.S. Naval publication remarks that the armament "pod" of the Mig-15 (and, presumably, that of the Mig-17 also) renders a portion of the structure rigid enough to take "the basic strain of an impact," although it is noted that the nose structure of an ordinary jet aircraft is not strong enough in itself. Technically, the same publication observes, the Russians imply that ramming tactics are easier today than formerly.

It is important, of course, to differentiate between the ordinary fighter, the locally strengthened fighter, and the special fighter of the sort which has been considered in the past and which might yet materialize (with recourse, perhaps, to homing aids and capsule escape for the pilot). The first could hardly be expected to survive an encounter; the second might stand a slender chance; the third, particularly if steel-built, might be used as a recoverable weapon. Unencumbered by armament it could achieve matchless performance; its first cost would be a mere fraction of that of a manned fighter/nuclear-headed-missile combination; and, as the C.A.S. recently remarked, we *know* that the manned fighter *works*.

"Flight" photograph

BELLIGERENT BEAUTY (reminiscent of Miss Marlene Dietrich fondling a brace of forty-fives) is this Hawker Sea Hawk FGA.6, carrying full war load. The Mks 100 and 101 for the West German Naval Air Arm will be basically similar (see news item below).

FROM ALL QUARTERS

The Sea Hawks Soar

WHEN Sir Sydney Camm and his Kingston design team laid out the trim Hawker P.1040 straight-wing Nene-powered fighter more than eleven years ago, they could not have foreseen that, following the adoption of a naval version by the Fleet Air Arm, the Sea Hawk (as the type became known) would ultimately pass into service with the Dutch and German Navies also.

Confirmation of the German order comes nearly ten years after the P.1040's maiden flight and must be acclaimed as one of the finest tributes paid to a British aircraft in recent times. Sixty-eight machines are involved, at a price of over five million pounds, including spares and equipment.

The contract was signed in Bonn on behalf of Armstrong Whitworth Aircraft (who have been responsible for developing and producing the Sea Hawk) by Mr. C. S. Emery, a director of the company. It follows the order placed by the Dutch Government some months ago for thirty similar machines.

The letter of intent was received by A.W.A. last August; meanwhile, officers of the West German Naval Air Arm have been studying the aircraft at Coventry. Last month they were accorded a civic reception by the Lord Mayor of Coventry, as their number included officers from Kiel, with which the Midland city has a bond of friendship.

Although originally stated to be of Mk 4 pattern, the German machines will, in fact, be designated Mk 100 and Mk 101, and will be basically of the latest—Mk 6—type, with internal modifications to meet German requirements. They will carry full deck-landing equipment and will retain the folding-wing feature in order that their pilots, who are to receive training in the U.S.A., will be able to use the aircraft carriers of other NATO nations (Germany having none of her own). Powered with Rolls-Royce Nenes delivering considerably in excess of 5,000 lb thrust, the German Sea Hawks will (according to a Hawker Siddeley announcement) be used for "patrol and reconnaissance." That the Sea Hawk is, at the same time, a potent strike weapon is indicated by the photograph above.

Hawker Headquarters Expansion

OTHER noteworthy news concerning Hawkers is that they are about to embark on what is described as "the biggest expansion and rebuilding scheme in the 47 years' history of the company."

This period, of course, dates back to 1910, the year in which T. O. M. (now Sir Thomas) Sopwith obtained his R.Ae.C. Aviator's Certificate. In 1912 he founded the Sopwith Aviation Company, with a disused roller-skating rink in Canbury Park Road, Kingston-upon-Thames, as his factory. It was here that the present Hawker factory and offices were established and expanded during World War 1, though the name of the Sopwith Aviation Co. gave place to that of the Hawker Engineering Co. in 1920. Sopwith war-time production also took place in a large factory a mile or so to the north, in Richmond Road. In the inter-war years this plant was acquired by Leyland Motors, but after the Second World War it reverted to aeroplane manufacture, with Hawker Aircraft as the occupiers.

It is this latter factory that will be the object of the big new building scheme. A four-storey office block—illustrated below—will have a 500ft frontage on the Richmond Road. Here will be situated a new design office of some 50,000 sq ft on one uninterrupted floor under a 400ft-span daylight roof, and its technical equipment is to include a flight simulator and the Ferranti Pegasus computer already in use in the existing offices.

At the rear of the factory, overlooking the Thames near Teddington Lock, a research and development building will be erected, with an area of 100,000 sq ft. It is to contain a variety of the most modern equipment, including a large structural test rig. Adjoining this building will be a two-storey office block of 20,000 sq ft, to house drawing offices, laboratories and other departments.

The new scheme will bring administrative, design, research and development activities into close conjunction, and there will also be new ancillary services such as canteens and recreation rooms.

At a time when much has been heard of a run-down of Hunter production, this bold new planning—the buildings alone will cost over £1m—is certain to bring general encouragement, particularly in the Kingston area.

G.91 Supersonic

THE prototype Fiat G.91 light ground-attack aircraft for NATO (Bristol Orpheus turbojet) has, on its twenty-fourth flight, been dived at supersonic speed four times in succession, at a height of 30,000ft. Announcing this, Fiat add that "the manœuvre to disengage from the sonic barrier was particularly easy."

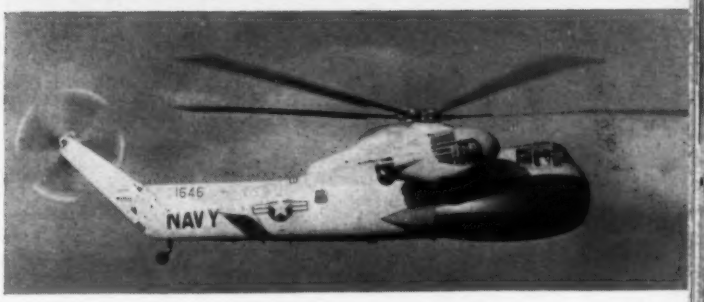
Missile Regiment Commander

LAST week it was announced that Lt-Col. J. E. Cordingley had been appointed to command 47 Guided Missile Regiment (Field), R.A., which is to start forming this month. [An announcement of its formation appeared in these columns on February 15.] Lt-Col. Cordingley is the son of A.V-M. Sir John W. Cordingley, who has been Controller of the R.A.F. Benevolent Fund since his retirement from the R.A.F. in 1947.

No-Prop Training

DURING the past fifteen months No. 2 F.T.S., Hullavington, Wiltshire, has been the scene of an important—and successful—experiment. Two courses have been trained *ab initio* to Vampire advanced trainer standard entirely on the Hunting Percival Jet Provost, and the standard they have reached (as we mentioned on page 230 last week) evoked very favourable comment from the examining wings of R.A.F. Central Flying School and of the NATO Air Training Advisory Group. Nearly 4,000 hours' flying have been accumulated on the Jet Provost T. Mk 1s in the third phase—assessment of the aircraft's qualities as a basic trainer—of the extensive trials that have been undertaken by the R.A.F.

HAWKER H.Q.: An architect's elevation of the new office block, at Kingston, described above.



***EXTRANEOUS, BUT PERTINENT:** External loads on three contrasting types of Service aircraft. Top, 50-gal wing tanks on one of the first two Folland Gnats for the M.o.S. (later versions will have 66-gal tanks); centre, the "guppy" (early warning) Sikorsky HR2S-1W of the U.S. Navy; and last, the Convair B-58 Hustler with its detachable weapons or counter-measures pod—virtually a second fuselage.*

Pupils—whether with or without previous flying experience—have found the aircraft easy to fly. The first course was scheduled to do 160 Jet Provost hours before converting to Vampire T.11s for a further 70 hours' advanced training, but it was found in practice that half of them could be transferred after 85-89 hours. The second course is flying 125 hours on the Jet Provost, to be followed by 85 hours on the Vampire—a valuable shift of training emphasis to the advanced phase.

Sir W. Verdon Smith

WE regret to record that Sir William Verdon Smith, C.B.E., chairman of the Bristol Aeroplane Co., Ltd., from 1928 until his retirement in 1955, died at his home in Bristol on February 19 at the age of 80. By profession a stockbroker, Sir William developed early in his career an extensive and accurate knowledge of company law and commercial practice and in 1901 was appointed secretary of London United Tramways. Later he became managing director of Bristol Tramways, Imperial Tramways, and the Corris Railway; and throughout his life transport in all forms remained his chief interest.

He became a director of the Bristol Aeroplane Co., Ltd., in 1927 and the following year succeeded his uncle Mr. Samuel White, of the Bristol stockbrokers George White and Co., as chairman. Sir William was thus at the head of Bristols from its growth as a privately owned concern to its conversion into a public company in 1935, throughout its wartime achievements and during its post-war contribution to civil air transport.

He received a knighthood in 1946, having been made C.B.E. in 1925. When he retired from the Bristol chairmanship in 1955 he was succeeded by his son Sir Reginald Verdon Smith.

Sir William is also survived by his widow (whom he married in 1934, his first wife having died in 1928) and a daughter of his first marriage.

Avro Arrow

LAST week Mr. Fred T. Smye, president and general manager of Avro Aircraft, Ltd., of Malton, Ontario, announced that "Arrow" has been officially agreed by Avro and the R.C.A.F. as the name of the CF-105 supersonic delta-winged all-weather intercepter.

Powered by two Orenda Iroquois turbojets, each rated at something over 30,000 lb thrust with afterburner, the Arrow is designed to be three times faster than the CF-100, i.e., it is in the 1,800 m.p.h. class, representing Mach 2.7 at altitude. Its ceiling will be about 64,000ft, which it will reach in three to four minutes. The first prototype is scheduled to enter the flight-test phase later this year.

Service-Civil Navigation Aids

AUTOMATIC V.H.F. fixer installations like those for the Fleet Air Arm, described in *Flight* last week, are being supplied to the Royal Netherlands Air Force and the Belgian Ministry of Civil Aviation, as well as to the R.A.F. All will be complete by the end of this year, the F.A.A. system being already in operation. Civil aircraft will be able, when necessary, to use the R.A.F. and R.N.A.F. military service; but the Belgian installation, with its ten C.R.D.F. stations and their central plotting room, is entirely civil and will provide a significant new traffic-surveillance system.

The automatic fixer, which is made by Standard Telephones and Cables, Ltd., employs a series of cathode-ray direction finder units whose voltage output signals are converted to a frequency system for transmission over two normal telephone lines. At the central plotting station, possibly over 100 miles away, the signal is reconverted to a voltage and combined with a time-base unit for presentation on a miniature (2½in-diameter) cathode-ray tube. The traces from up to ten of these miniature tubes are then projected by normal television techniques on to a ground-glass map screen, their points of origin being aligned with the geographical location of the C.R.D.F. station on the map.

The Belgian screen will reproduce a complete coloured map of the Belgian airways. In addition, the plan position display of a French-built surveillance radar will be converted to a television display and projected on to the same screen so that the blips of aircraft will be continually displayed on it. Any blip can then be positively identified by a short V.H.F. transmission from the aircraft to operate the automatic fixer traces. In terms of air traffic control, this represents a great advance over present systems. The combination of the two displays was originated by Mr. Raymond Lecomte, Director-General of the Belgian Régie des Voies Aériennes.

Warton Improvements

SEVERAL major improvements are being carried out by the English Electric Co. to their airfield at Warton, near Preston, Lancs. The main runway has been extended, at a cost of over £250,000, by 850 yd and is now 2,850 yd long. With additional concreted undershoot and overshoot areas, total length available in emergency is 3,130 yd. Construction work on it was done almost entirely mechanically and the labour force employed on the site by George Wimpey, Ltd., the contractors, never numbered more than 30.

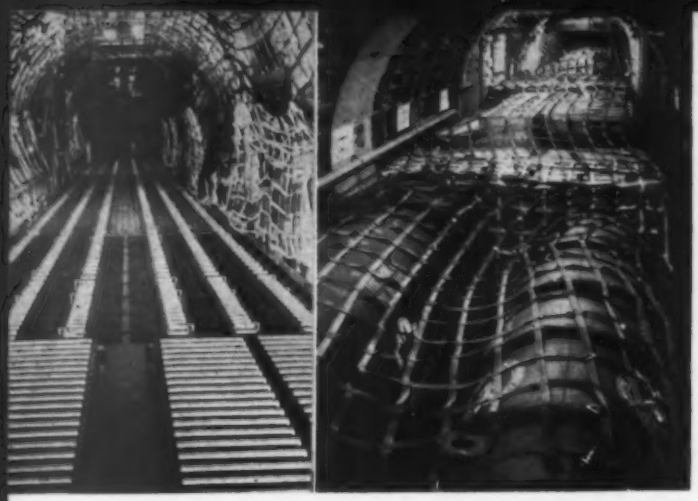
Three other improvements in course of installation are a new control-tower fitted with the latest V.H.F. and D.F. radio aids (supplied by the Marconi Co., a member of the English Electric group); new runway approach lighting; and an I.L.S. system.

These additions are due to be completed this year, say the company, and with the lengthened runway will enable flight testing of the P.1 for the R.A.F. to go on "unhampered" at Warton.

New Engine for Ultra-lights

WORK is progressing on the preparation of a four-cylinder, horizontally opposed engine giving about 30 h.p. and suitable for ultra-light aircraft. Made by Rollason Aircraft and Engines, Ltd., Croydon Airport, Surrey, it is "an extensive modification of a car engine which has been widely used for ultra-lights in France."

Initially known as the R.T.W. Mk 1, the new engine will, it is hoped, be marketed in the near future. The first example is being tested and calibrated and will probably be air-tested in a single-seat ultra-light. It is designed to use 80-octane petrol (i.e., good-quality car fuel), and to consume about 1.36 gal/hr at 2,500 r.p.m. Dry weight is about 130 lb. Dual ignition is fitted, with one 14 mm and one 12 mm plug in each cylinder. Similar engines in France have been developed to give about 35 h.p.



NETWORK: The floor of the C-133A (news item below) is seen on the left with cargo nets lashed clear; in the immediate foreground are the rollers of the loading conveyor, and then those of the aircraft ramp. Right, the nets in position over a load of P. and W. T34s—turboprops of the same type as the four which power the aircraft.

FROM ALL QUARTERS . . .

Loading the C-133A

DETAILS have been released of a new quick-loading and unloading system designed for the Douglas C-133A military transport. Claimed to be the fastest method yet devised, it utilizes multiple roller-conveyors, pre-loaded cargo pallettes and a new net tie-down technique. The roller conveyors need not be installed permanently and, in the C-133A, can be locked into position on existing cabin fittings in about five minutes. They are used in conjunction with corresponding conveyors on a simple loading dock of matching height.

Following a recent two-day military evaluation of the system at Douglas's Long Beach plant, a full-scale demonstration was staged, in which a simulated M.A.T.S. load of 68,000 lb was moved into a C-133A fuselage mock-up. Made up of mixed cargo such as engine containers, wing panels, turbojet tailpipes and small packages, the load was winched into the 13,000 cu ft cabin. It was then secured with webbing cargo nets dropped over it by a pulley system. Unloading was made equally easy by hoisting up the nets to leave the floor free of obstructions (see left-hand illustration).

The 90ft-long cabin of the C-133A is large enough to accommodate 96 per cent of all types of U.S. ground force vehicles fully assembled. Simultaneous front and rear loading is possible through an entrance suitable for 12ft-high vehicles at the rear, where the floor is 142in wide, and a smaller door on the port side at the front, measuring 100in high by 106in wide.

Newly released facts and figures about the big transport give its empty weight as 111,715 lb and useful load as 143,285 lb, typical payloads being 50 short tons for 1,380 statute miles or 25 tons for 4,000 miles.

Detailed design began in February 1953 and the first production aircraft—there were no prototypes—was rolled out in February 1956 [a description appeared in *Flight* of April 27, 1956]. By the end of the year three C-133As were flying at Edwards A.F.B. and another was undergoing climatic testing at Wright-Patterson A.F.B.

The C-133A should not be confused with the twice-as-heavy C-132. The latter (picture, page 231 last week) is in mock-up stage at Douglas, Tulsa; the C-133A is in production at Douglas, Long Beach.

Modellers' Anniversary

NO occasion presided over with such Pickwickian geniality as Dr. A. P. Thurston's could fail to be warm-hearted; and so it proved when the Northern Heights Model Flying Club held their annual dinner and dance in London last Saturday. Dr. Thurston's good humour—"I know Sir Dermot Boyle is glad the R.A.F. has got the Northern Heights behind it," he said solemnly after reading an apology for absence and good will message from the C.A.S.—permeated all the proceedings. Air Chief Marshal Sir Hugh Lloyd, congratulating the club on its victory in the British controlled-glider competition and hoping that this year it would gain the international record, praised Dr. Thurston's "Peter Pan" zest.

Mr. C. A. Rippon, with a proud reminder that this was Northern Heights' 25th year, recalled days with other founder-members at Parliament Hill Fields in 1931. The club's "camaraderie" with the R.A.F. was personified by the presence of G/C. B. Robinson, new chairman of the R.A.F. Model Aircraft Association, and of S/Ls. W. C. Parsons and N. Paxton, who were thanked for their co-operation at Halton. Mr. K. M. Tansley wittily expounded the aero-modellers' good domestic relationships, and could hardly have been more aptly answered when Mrs. Jean Warwick said she would rather have her table covered with balsa-wood chips than her hearth-rug with pieces of motor cycle. Lady Lloyd presented trophies for last year's successes and the general happiness radiated into dancing to conclude another Northern Heights "occasion."

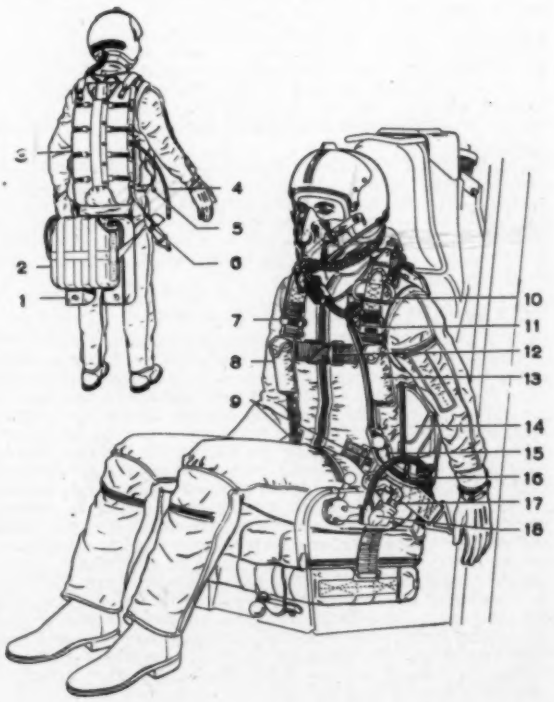
FASHION FOR A4D PILOTS

A New Integral-harness Suit

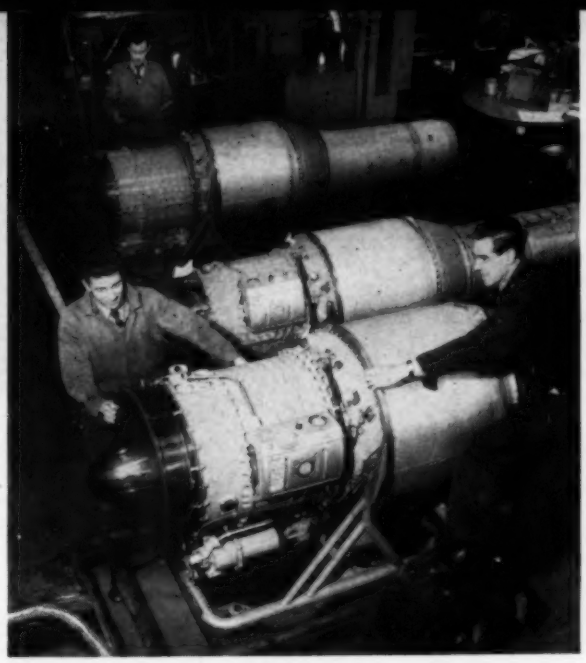
ALL pilots flying the U.S. Navy's A4D Skyhawks are to be issued with a new flying suit having integral parachute and seat harness and flotation gear. Developed by Douglas El Segundo Division in conjunction with the Naval Parachute Unit at El Centro, California, the new garment is being produced by the David Clark Company of Worcester, Mass.

Seat- and parachute-harness are both incorporated in the suit, leaving four quick attachments to be made between the pilot and seat—an arrangement similar to that of the Parasuit developed in this country some years ago by the G.Q. Parachute Co. Oxygen, radio and g-suit leads in the American suit are led inside covers to the left hip and plugged into a combined connection located close by. Parachute and survival pack remain attached to the suit rather than being left in the seat as is the case with British equipment. Flotation gear, of unspecified configuration, is carried folded below the armpits of the suit and triggered by individual lanyards on each side. Two signal flares are carried in "built-in" pockets either side of the chest.

The accompanying illustration of the suit also shows the pilot wearing the new American standard protective helmet, the sliding visor of which is covered, in the retracted position, by a fixed plate. The helmet is lined with a foamed-plastic material designed to collapse at a predetermined loading. This, it is claimed, provides better shock absorption than the traditional tape cradle.



The new Douglas integral-harness suit for A4D Skyhawk pilots. 1, seat cushion containing oxygen bale-out bottle; 2, PK-2 dinghy pack; 3, parachute; 4, barometric parachute-release lanyard; 5, flotation gear actuating lanyard; 6, lap-strap adjustment; 7, shoulder harness and parachute attachment; 8, signal flare; 9, seat belt and parachute attachments; 10, parachute ripcord handle; 11, shoulder harness and parachute attachment; 12, suit harness adjustment buckle; 13, signal flare; 14, flotation gear; 15, oxygen and radio connection; 16, flotation gear actuating lanyard; 17, g-suit connection; 18, oxygen and radio connection on console.



COMPACT POWER FOR NATO: Above, an Orpheus BOr.3 (see paragraph below) on its way to the Marcel Dassault works in the cabin of the French company's Dakota. In the group, left to right, are Capt. Boudier, Signals Officer Formento and M. Barbarau of Dassault, Mr. A. J. Thorne of Bristol Aero Engines, 1st Officer Stora of Dassault and Mr. J. H. Fox of Bristol Aero Engines. In the picture on the right the first BOr.3s are seen coming off the production line at Bristol.

HERE AND THERE

Bowler Hatted?

ACCORDING to a Moscow report, Marshal Zhigarev has been removed from command of the Soviet Air Force and put in charge of Aeroflot, the State airline. He is succeeded as commander-in-chief by Marshal Vershinin, deputy C-in-C. and commander of the Soviet strategic air force.

Airborne Artillery

A HELICOPTER armed with a 57 mm recoilless cannon and three machine-guns is being used against Algerian terrorists, it has been disclosed by the French Defence Ministry. With a crew of two pilots and three gunners, it is used both to escort formations of helicopter-borne troops and to support ground forces. The gun is shortly to be replaced by a rocket launcher.

Burtonwood to Close

SEVERE economic repercussions may be felt in South Lancashire as a result of the decision to close the U.S.A.F. base at Burtonwood. The Air Materiel Command has announced that it has consolidated all procurement for Europe in the Central Air Materiel Area at Chateauroux, France. Northern A.M.A. (Burtonwood) is eliminated and the £121m in contracts formerly administered there are being transferred to France.

Weather-beaten Replica

A REPLICA of *The Spirit of St. Louis*, the aircraft in which Col. Charles Lindbergh flew non-stop from New York to Paris in 1927, was given a lift recently in a Globemaster after being unable to complete a California-New York flight owing to bad weather. It had flown as far as El Paso, Texas, then was taken aboard for the rest of its journey *en route* to the site of Roosevelt Field, where Lindbergh took off. The replica is one of two built by Paul Mantz for the film of Lindbergh's life.

First Orpheus BOr.3 Deliveries

FIRST deliveries of the Bristol Orpheus BOr.3s ordered for NATO light fighters have recently been made, the engines being delivered to Fiat at Turin and Marcel Dassault at Saint Cloud. Those for Fiat will be used in the G-91, the first prototype of which flew seven months ago with an earlier mark of Orpheus, while the engines delivered to Dassault will power the Etendard VI. Over 6,100 hours of Orpheus running have now been completed, including 190 flight hours in the Folland Gnat, Fiat G-91 and Avro Ashton test-bed. The BOr.3 develops 4,850 lb thrust.

Dutch Army Co-operation

LAST year about 50 Hiller H-23 helicopters and some 24 DHC-2 Beavers were supplied to the Royal Netherlands Army for liaison and Army co-operation duties. They are flown and maintained by Air Force personnel.

Outdoor Photography

NEXT week's issue of our associated journal *Amateur Photographer*, published on March 6, will be an "Outdoor Number" containing special articles and illustrations designed to provide guidance on out-of-doors camera techniques.

The Douglas Giant

IT is reported that the U.S.A.F. will place no production contract with Douglas Aircraft's Tulsa division for the giant C-132 transport until the type has been fully evaluated in flight trials; at present two only are on order. (A photograph of a mock-up appeared on p. 231 of last week's issue.) Dimensions recently announced by the U.S.A.F. include: span, 178ft (this is lower than that of the smaller C-133, owing to the considerable sweep of the wing); length, 187ft; hold dimensions, 95ft by 204in wide by 150in high. Gross weight will exceed 500,000 lb.

MR. G. C. D. RUSSELL, assistant managing director of Handley Page, Ltd., has been appointed a governor of Hendon Technical College. There are close links between the company and the college, where many H.P. craft apprentices have additional instruction.

Lockheed Prospector

A LOCKHEED 12 equipped with two mineral-detecting magnetometers, one suspended by a 100ft cable and the other attached to a boom projecting from the rear of the aircraft, is to be used by the Norwegian Department of Commerce for ore-prospecting operations.

The Last AD

ON February 18 the El Segundo Division of Douglas delivered the 180th and last AD-7, the final model in the Skyraider series. The Skyraider had been in continuous production for twelve years and substantially more than 3,000 have been delivered to the U.S. Navy.

Down to the Sea

A CONTRACT has been awarded by the U.S. Navy Department to Flight Refueling, Inc., Baltimore, Md, for the design and manufacture of ship-to-ship refuelling equipment. The prototype, consisting of nozzle and coupling assemblies for ship-board operation, will be similar to those the company has developed for air refuelling.

U.S.A.F. Intercepters

A YEAR ago the U.S. Air Force abandoned plans for a long-range intercepter after bids had been called for a number of designs. It is now reported that design proposals for a medium-range intercepter are being considered. Studies are believed to have been submitted by Convair, Lockheed, North American, Northrop and Republic.

Operation Bananas

A CONTRACT for the aerial spraying of over 6,000 acres of banana plantations in Jamaica seventeen times during the course of a year has been awarded to Fison-Airwork, Ltd. This is said to be the first time banana crops have been extensively sprayed from the air. Fison-Airwork are purchasing two Hiller 12Cs and one Piper Super Cub to carry out the work; they will spray orchard oil to combat leaf spot.

THE FAIREY DELTA 2

Part II of the Lickley/Twiss Lecture: Flying "A Very Pleasant Machine"

AS recorded in these pages last week, a "main" lecture of the Royal Aeronautical Society, with the Fairey Delta 2 as its subject, was given on February 14 by Mr. R. L. Lickley, B.Sc., F.R.Ae.S., technical director and chief engineer of the Fairey Aviation Co., Ltd., and Mr. L. P. Twiss, test pilot of the company. (Mr. Twiss secured the world's air speed record with the F.D.2 nearly a year ago, at a speed of 1,132 m.p.h.). Last week we reported the first part of the lecture—Mr. Lickley's dissertation on the design and construction of the aircraft; and the general discussion was summarized in our news columns. Below we give points from the test pilot's contribution to the joint paper.

"THIS aircraft shows every promise of being a very pleasant flying machine. Soon after take-off I had confidence in the handling characteristics, and I should like to congratulate all the design and engineering personnel who made this possible." These words, said Mr. Twiss, were from the opening paragraph of his flight-test report on the Fairey Delta 2, and they still rang very true today.

The great day [continued Mr. Twiss] was October 6, 1954, at Boscombe Down, and was the start of an intensely interesting development programme—not without its setbacks and excitements—which was highlighted last March by the gaining of the world's absolute air speed record for Britain. The early flights followed the pattern of most prototype aircraft and, but for an unfortunate setback on the fourteenth flight, went very smoothly.

This was the first aircraft in this country to fly with powered controls with no means of manual reversion, i.e., the controls were entirely irreversible, the pilot's control column being purely a selection lever to a system of valves. With the system as it was arranged, every component was duplicated except the engine. There was a pump, hydraulic supply pipes, jacks, valves, and so on, for each system. We made a large number of ground tests. An extreme case was taken—an engine seizure at altitude with the reserve accumulator pressure at the level at which the pumps were about to cut in. Typical flight manœuvres during a descent and landing in calm and rougher air were simulated, following the flight pattern suggested by the R.A.E. in the simulated cases done on the Avro 707. The results of these simulated manœuvres were encouraging. It was found that more than 1,000 deg of control surface movement, used as required, were available. This was thought to be sufficient for an emergency let-down from 30,000ft and a landing.

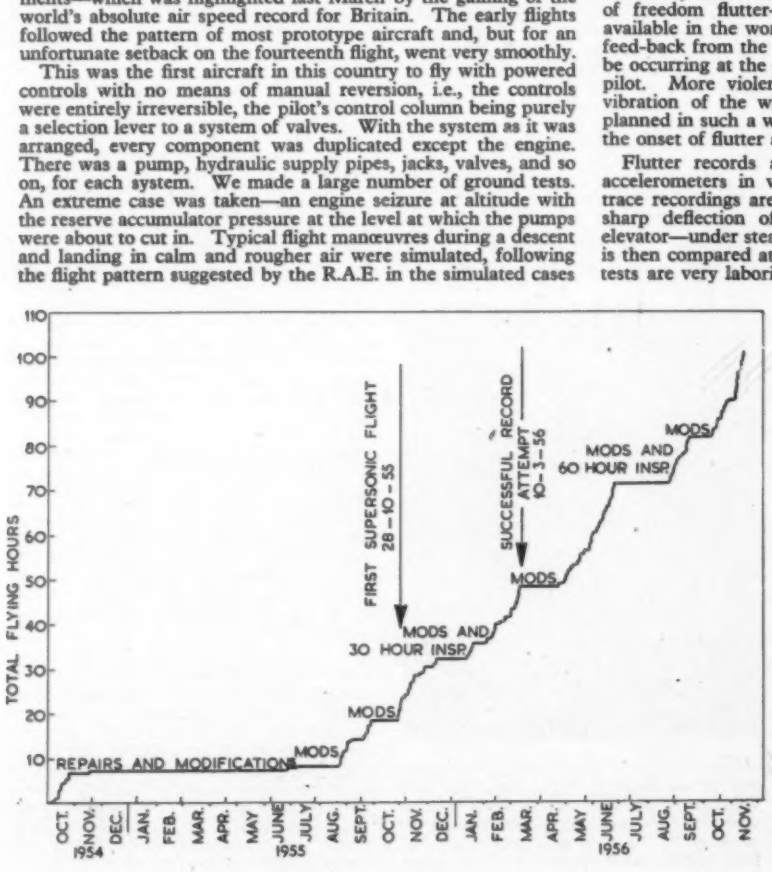
These ground tests were put severely to the test on flight No. 14, when I suffered an engine stoppage some 30 miles from base, and was able to glide back and make a wheels-up landing. Further improvements have now been made; a ram-air-driven turbine hydraulic pump is now available for such an emergency.

Control Flutter Testing. Many people ask why we took so long to work up to supersonic flight. "Hasten carefully" is the motto of a sensible test pilot and flight development team; and there was a very special reason why the flight envelope should be extended with care. This was the first high-speed aircraft to fly in this country without any mass balance on the control surfaces. Theory had suggested that sufficient stiffness could be obtained through the powered control system to guard against "classical" flutter and, that mass balance *might* well make things worse! The space was still available in the wings and fin, but approximately 1,000 lb of dead weight was saved by not fitting mass balance. However, there was still an element of doubt about single degree of freedom flutter—little practical experience of which was available in the world. Of this type of control system, with no feed-back from the control surface to the stick, mild flutter may be occurring at the control surface without any indication to the pilot. More violent flutter would of course be apparent by vibration of the whole airframe. Flight tests were therefore planned in such a way as to obtain as much previous warning of the onset of flutter as could be arranged.

Flutter records are obtained by mounting small recording accelerometers in various parts of the structure. Continuous trace recordings are taken of the effect of the pilot initiating a sharp deflection of all three surfaces—rudder, aileron, and elevator—under steady conditions. The measure of the damping is then compared at various speeds and Mach numbers. These tests are very laborious, as, for reasons of safety, it is necessary to increase the speed in small increments, processing and examining the records between each step. A deterioration in damping would act as a warning to proceed in smaller increments or even to stop. The average increment of Mach number was 0.01, with examination of records every 0.02 over the regions theoretically supposed to be critical.

It is worthy of note that the flight-development and maintenance team worked up to a high degree of efficiency. The aircraft would be ready to take-off on its next flight, refuelled, records examined, auto-observer replenished, and so on within forty minutes. This enabled us to make four to five flights of this type in a day.

Control and Stability. During the flutter testing a considerable amount of information was obtained about the stability of the aircraft. Elevator angles to trim and to manœuvre, and so on, were obtained throughout the flight envelope covered and conventional stability checks were made both subsonically and supersonically. Extensive longitudinal manœuvr-



Serviceability record of the Fairey Delta from the first flight to mid-November 1956.

THE FAIREY DELTA 2 . . .

ing tests have been made. Stalling of the elevator jacks allowed only a limited application of g at high supersonic speeds.

Positive directional stability continues up to the maximum Mach number attained and, as far as the pilot is concerned, no apparent change occurs in directional damping following a rudder kick.

Within the flight envelope covered up to the present time, no artificial stability devices have been found necessary. The accuracy with which the height tolerances in the speed record were maintained is evidence of the standard of supersonic stability and control available.

Control Harmonization. With the wide speed range this aircraft is designed to cover considerable thought has been put into the pilot's controlling problem. With manual controls, the pilot is physically prevented from applying large elevator angles by excessive hinge moments. The introduction of power controls has overcome the force problem but, in some ways, has left a more difficult situation. For example, on the F.D.2 the result of moving the control column one inch at the two extremes of the supersonic speed range could give the difference between $\frac{1}{4}$g or less near the stall, to 5 or 6g at 500 to 600 kt. This obviously makes the provision of some feel system an important feature. A simple pre-loaded spring is fitted to the control column and rudder bar to provide feel and self-centring.

We tackled this problem by producing both a non-linear relationship between pilot's stick and control and also, a system of variable gearing. This is at present operable by the pilot and available on both aileron and elevator. The pilot can maintain the same relationship between stick movement (and therefore force) and g, or rate of roll at both ends of the subsonic speed range.

Supersonic Flight. The first supersonic flight was made on October 28, 1955, and was notable for its smoothness. It is quite true to say that after a gentle nose-down trim change at about M = 0.95 there is no indication that the aircraft has slipped from high subsonic flight to supersonic flight at high altitude, other than the transonic phenomenon of the flight instruments—best described as a "transonic flick"—where the machmeter, altimeter and A.S.I. needles "flick" to a new datum.

In the early stages all supersonic flight had been made with engine less reheat, this power being sufficient to take the aircraft up to about M = 1.1. Slight dives were made to achieve supersonic flutter tests up to M = 1.2.

Following extensive ground tests the engine/reheat system was used. The very marked acceleration that occurred after reheat had been lit was an embarrassment to accurate flight test results and, in fact, in early flights gave the pilot a feeling of loss of control!

The reheat system available at that time was virtually an on-off selector. This had the effect of nearly doubling the available power at 36,000ft. Alterations have been made in recent months to provide the pilot with more selective control of this large increase in power.

For convenience, relatively low-capacity l.p. fuel pumps were initially provided in the fuel system, but this restricted the use of reheat to 25,000ft and above, where maximum fuel demands were of an acceptable order.

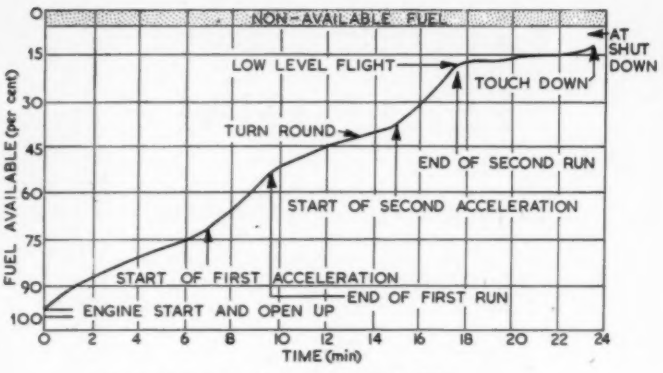
It was necessary to light reheat during the subsonic climb. This resulted in what felt like, at the time, a meteoric climb to altitude. During this climb it was difficult to avoid exceeding the Mach number and air speed at which satisfactory flutter tests had already been covered. At the correct height the speed had to be stabilized for the new series of flutter tests. This technique also resulted in an uneconomic usage of fuel which curtailed the useful time for flight data.

Flight Progress. During all this flying, valuable data were being obtained on skin and structure temperatures, control effectiveness, and so on. During most flights the automatic observer, which photographically records more than 60 instruments and indicators, was in continuous operation.

An intensive period of flying for a few weeks results in a lay-up for a few days to embody modifications found necessary before the next phase and for inspections, and so on. The steady rise in the hours flown on this one aircraft is very creditable when compared with other research aircraft. It must be remembered that the average length of a flight is of the order of 20 to 25 minutes. Over 250 flights have been achieved up to the present time.

To summarize, the early flight development, apart from the forced landing due to the fuel failure, went very smoothly. There were no cases of mechanical difficulties with the power controls. When the aircraft was in a flying state, i.e., no modifications or inspections being carried out, the accumulation of flying data proceeded rapidly. Four flights in a day were frequently achieved.

Supersonic Flight Below 30,000ft. After describing in considerable detail his successful attack on the world's speed record, Mr. Twiss went on to deal with subsequent development flying.



Fuel consumption during the record flight.

In view [he said] of the various problems of carrying out a supersonic flight test programme in the autumn in the United Kingdom, a suitable base elsewhere was sought. Agreement was reached with the French Air Ministry and the Centre d'Essais en Vol for the use of the base at Cazaux, near Bordeaux, in south-west France. The French offered us, and provided, every assistance. This area has a good weather record, is reasonably sparsely populated and, if necessary, is within daily communication range of the United Kingdom by Rapide aircraft.

The F.D.2 was flown out from Bedford on October 11 and the trials started on October 15. Between October 11 and November 15, when the aircraft returned to Bedford, 52 sorties were flown. Approximately six hours were spent in flight at above M = 0.96 and supersonic flight was achieved down to 3,500ft.

Throughout all these supersonic runs the primary object of the visit was achieved. "Stick tapping" tests were made and recorded to the extremes of the flight envelope. Pressure measurements were also made. The weather was a major factor in allowing such rapid progress. Smooth, fine conditions, essential for the stick tapping, are seldom available in the United Kingdom. The serviceability of the aircraft during the period of the trials was excellent. Only slight delays were experienced, these being due to the distance from spares and technical advice.

Mr. Twiss concluded: There is much more interesting research yet to be done on the F.D.2. It is likely to be flying hard all this year and longer.

This concept of a research aircraft for the supersonic speed range M = 1.0 to M = 1.75 has proved excellent for operation in the United Kingdom with the airfields that are available and the very variable weather.

The 250 flights that have been made, which include many hours of supersonic flight time, are a proof of the value of a flexible aircraft design.

LEVIER ON TEST FLYING

INTRODUCING his paper, *Flight Testing and Flying Techniques of High-Altitude Supersonic Aircraft*, at a recent meeting of the Society of Automotive Engineers in Detroit, Anthony W. LeVier (director, flying operations, Lockheed Aircraft Corporation) said that the F-104 had exceeded its speed specification by a healthy margin and had reached altitudes some 10,000ft higher than expected. "As with all new aircraft," he said, "we found some strange behaviour."

Discussing the difficulties of modern test flying, he said: "Let us consider just a simple high speed-run in a new supersonic fighter. No longer can we confine our flight testing to that large expanse of arid land known as the Mojave desert. Now after taking off from either Edwards Air Force Base or Palmdale in about six or seven minutes we have not only reached 50,000ft or higher, but we are speeding along at well over Mach one and are 80 to 100 miles from home base. We may have headed in a south-easterly direction, crossed the Sierra Nevada mountain range over Palm Springs, and on to the Imperial Valley. Here we swing around for lack of country, for Mexico is just ahead. Now we may push the throttle lever full forward for a maximum level-flight speed. In five minutes we are back home, having covered in 11 or 12 minutes a ground distance equivalent to a day's travel by automobile."

In spite of the "blazing speed" of the new aircraft, said the lecturer, 90 per cent of the time in the air was spent at less than half speed. Cruise and low-altitude climb speeds unfortunately fell right at the point where the Machmeter position error occurred near the speed of sound. This could be serious, particularly if the pilot was unaware of this error and cruised too fast, thereby consuming excessive amounts of fuel.

Talking About TITANIUM

The Present Position of the Metal in the British Aircraft Industry

In two years I.C.I. have twice replaced their titanium-melting furnaces with new patterns. Here an 800-lb ingot is being transported past a line of furnaces with remote control and blast protection.

EARLIER this month, in London, senior executives of Imperial Chemical Industries, Ltd., delivered prepared addresses on various basic aspects of the titanium industry. They particularly addressed themselves to the British aircraft industry, their largest customer for the titanium alloys at present available. We present here shortened forms of the seven papers, together with a table showing the composition and chief mechanical characteristics of I.C.I.'s current titanium alloys. It is noteworthy that I.C.I. produce well over 90 per cent of all British titanium.

THE GENERAL PICTURE

By Dr. Maurice Cook, Joint Managing Director, I.C.I. Metals Division

TITANIUM is a new metal but not a rare one. It is new in the sense that, although its existence has been known since 1791, it is only within the last decade that it has become a product of metallurgical industry. It was not until 1925 that it was made by van Arkel, albeit on a small experimental scale, in a state of sufficient purity for an assessment to be made of its properties and of its potential value as an engineering material. So far, it has not been possible to translate the van Arkel technique into a large-scale and economically attractive extraction process; and it was, in fact, left to W. J. Kroll to devise, for the production of ductile titanium, the first industrial process, which he described in 1940.

This discovery was followed by commercial production in 1948 when about 2-3 tons of metal were made in the U.S.A. and sold at a nominal price of $5 per lb. Since then production has continued at a rapidly increasing rate and, although by far the largest output is from the U.S.A., the metal is being made elsewhere, especially in this country and Japan. Most of the titanium so far produced has been by the Kroll process, but an alternative method has been developed by I.C.I. and is being worked in this country, whereby sodium is used as the reducing agent instead of magnesium. In 1956 the total production of raw titanium was approaching the 20,000-ton level and in 1957 it might be nearing 30,000 tons. In the short space of three years or so the price of raw titanium has been nearly halved. All this adds up to an impressive achievement.

The solving of problems associated with various aspects of titanium technology has occasioned a prodigious concentration of effort, the like of which is without parallel in metallurgical history. It is, in fact, true to say that the development of an industrially workable process for the extraction of titanium, the devising of melting techniques, and the production in wrought forms of the metal and those of its alloys that have so far been produced on an industrial scale, represents one of the most outstanding metallurgical achievements of this or any other century.

It may fairly be asked what aroused the interest in titanium that became so manifest, especially in the U.S.A., ten years or so ago. The simple fact would seem to be the advent of the Kroll process as a method of producing, in quantity, a metal that had properties of significance and importance in service applications. In short, the possibility was visualized of making available a new metal of great potential to the aircraft industry, and in the longer term to other industries also; for it was known then that it possessed other valuable distinguishing properties such as, for example, outstanding resistance to corrosion.

Furthermore, it was known that it occurred abundantly in the form of workable ores in many parts of the world; indeed of what might be termed engineering or structural non-ferrous metals, its abundance in the earth's lithosphere is exceeded only by that of aluminium and magnesium. There was thus incentive enough to encourage technical effort on a major scale.

It is also probably true that because of the relatively high melting point of the metal, that is 1,660 deg C, the hope was cherished that alloys might quickly be forthcoming which possessed a high degree of strength-retention at elevated temperatures. Although this has not so far been realized, you will be hearing later that a good deal has already been accomplished in developing new alloys with interesting and attractive properties, and greater advances can with confidence be looked to in the future.

Users, of course, are interested in prices as well as properties; but I am not going into details of this aspect except to say we would expect that prices of I.C.I. titanium products generally might, by 1960, be about half what they are today.

Looking further ahead, and in so doing offering—I would emphasize—a purely *personal* view as a metallurgist, I think both the attractions and the possibilities of titanium are such that a substantially increasing production and use for this metal are assured. I find no difficulty in visualizing a world level of annual output of 100,000 tons in ten years' time and appreciably more thereafter. Speculation on prices likely to prevail at that distance of time would be just too much of an excursion into the unknown for me to embark on. It is, however, conceivable that the price of fabricated forms of titanium on a weight basis might, in time, be about twice that of stainless steel, which approximates to a cost parity by volume.

The cost of titanium in ore form is in pence a pound; in wrought forms it is £ a pound. The reason for this enormous spread derives essentially from certain unalterable physical-chemical properties of the metal, such as its intense reactivity, especially in the molten state; its facility for dissolving its own oxide; the affinity it has for such elements as nitrogen, carbon and hydrogen; and the effect they have on its properties. It is indeed these characteristics which have necessitated the complex and exacting techniques involved in extracting the metal and its subsequent processing.

Further improvements to existing extraction methods, with a cheapening of them, will continue; and radically new ones might be devised. Again, in further processing, improved and new techniques, plant and equipment will be developed, as indeed they are being.

THE COMMERCIAL POSITION

By Michael Clapham, Joint Managing Director, I.C.I. Metals Division

IN dealing with the status of titanium among the metals, Dr. Cook has said something of its theoretically possible price. What I want to do is to say something about the factors you have to take into account when deciding whether and how much to use it today—its present price in wrought forms, and why it is high; the extent and probable timing of its reduction; and the supply/demand relationship as we expect it to be over the next few years.

Let us take the position of supply and demand first, because the level of production has a direct bearing on the price. At present the total manufacture of wrought forms of titanium in the United Kingdom is running at the rate of about 400 tons a year—well over 90 per cent of it being done by I.C.I. For comparison, the rate of manufacture in the United States is at the rate of about 500 to 600 tons a month, more than twelve times as much as ours. In both countries the aircraft industry is the main consumer, and many of you will be able to judge better than I how far that factor of 12 represents a difference in the size of the two countries' aircraft industries, and how far it is accounted for by a higher rate of usage over there. Certainly it seems likely that the proportion of titanium to the total weight of aircraft produced is higher in the U.S.A. than here. The same may be true of the U.S.S.R., the only other country with a large-scale industry producing wrought titanium; though we have, of course, no figures about titanium or aircraft production there.

Although, as Mr. Elstub will explain, our present plant has limitations, it is in general true that the main factor restricting production is lack of demand. That in turn raises the unit cost, since the fixed costs are very heavy—research and technical service, costing substantial fractions of a million yearly; the capital charges on specialized plant during the period of under-utilization; and the tremendous rate of obsolescence that goes with a rapidly developing technology—for example, we have had three sets of melting furnaces in two years.

In spite of these handicaps we have, as you know, reduced the prices of our wrought products by about 10 per cent this month. They are, however, still generally rather higher than in the United States. We hope—and intend—to reach parity quickly: indeed, given anything like the same scale of production, we should be able to manufacture more cheaply than in the States, as we can with copper-based semis. If the present trend of usage continues, we should be running level by 1959/60.

Apart from through-put, the main factors affecting costs are the price of raw material, the size of the ingots handled and the efficiency of plant and practice—including the extent to which scrap can be utilized. Mr. Elstub will be dealing with the questions of plant and production practice: you will gather from what he says that we have no intention of failing to provide whatever capacity is called for, and little fear that we shall not be able to remain at least as good technically as any other

TALKING ABOUT TITANIUM . . .

producer in the world. We expect to reduce costs continuously, by improved methods; though to do so has meant and will mean heavy capital expenditure.

The price of raw titanium granules now accounts for less than half the cost of fabricated products, even allowing for the fact that process losses in fabrication are very high. We are helped here by the fact that the General Chemicals Division of I.C.I., who produce the granules, have consistently been able to keep their price below that of American titanium sponge. This has been possible mainly because the sodium process which they developed is inherently rather cheaper than the Kroll magnesium process. They have also been helped by having a guaranteed market: unlike the production of wrought forms, which is purely an I.C.I. venture, the production of raw titanium is backed by a Government undertaking (incorporated in an agreement with the Ministry of Supply) to buy up to 75 per cent of the production of I.C.I.'s 1,500-ton plant, at a price not exceeding the current world price. This guarantee has made it possible to maintain production at a reasonably economic level. It has also provided the Ministry with a stockpile of which the country may be very glad when its requirements of raw titanium begin to exceed the capacity of our present plant—a thing we expect to happen during next year.

Dr. Cook has already told you what we expect the price of wrought titanium products to be in 1960. In our forecasting we have taken 1960 as a reference point, because we can get a fair idea of the potential and probable demand that far ahead: it can be presumed that no engines or aircraft not now in the prototype stage will be in bulk production by then. Our estimate that the price of wrought forms of titanium will come down to about half its present level by 1960 takes into account what we expect to be the U.K. demand in 1960—including some exports; allows for the increasing plant efficiency and the increasing use of scrap which we can at present foresee; and allows also for some further reduction in the price of raw titanium granules.

That estimate, of course, is an estimate of the average price: it may be that the price of particular products will be higher—or a good deal lower. So much depends on the extent of plant utilization, and other factors which vary with the scale, that we would like to discuss with all potential users what their future requirements might be at a range of different price levels. We are already having discussions with one or two firms represented here, and hope, as a result of this conference, to start more. The aircraft industry is no longer the sole consumer of titanium. Uses in engineering, particularly chemical engineering, are beginning to develop. But the aircraft industry's requirements are still the main factor governing both demand and price, and we hope that this conference will help to influence both.

PRODUCTION POLICY

By St. J. Elstub, C.B.E., Production Director, I.C.I. Metals Division

AS many of you may know, the production of the raw titanium granules is the responsibility of the General Chemicals Division of I.C.I. Their plant at Witton has a designed capacity of 1,500 tons per annum, but modifications made primarily from the point of view of improving quality will have the effect of increasing this figure somewhat from April of this year. Given 18 months' notice, the output could be increased still further by several hundred tons a year, but for major increases a completely new plant would be needed, together with additional sodium capacity; and this would take three years to design and build. Under the arrangements with the Ministry of Supply, the plant is now being run at an output in excess of immediate requirements, and, over the next two years, a considerable stockpile will have been built up. This fact, combined with the re-cycling of quantities of scrap which will inevitably increase, means that raw material supplies are most unlikely to represent a short-term bottleneck. And it should be possible to plan well ahead to deal with long-term increases in demand.

At the time of the last conference [1954], we were producing 230-lb ingots by single melting with graphite electrodes in argon. Two types of furnaces have become obsolete since then, and we are currently producing 800-lb ingots, all of which are double-melted from consumable electrodes in vacuuo. By this time next year, we shall be producing 1-ton ingots as our standard production, with facilities for melting 2-ton ingots as and when required. All this means that we shall have written off four sets of furnaces in four years; but, as a measure of the increase in efficiency achieved, the same electrical supply which provided capacity for 1,500 tons of single-melted material in 1955 will produce between 1,800 and 2,000 tons of double-melted ingots in 1958.

So far, on melting, our main problems have not been metallurgical. Some difficulties have arisen from safety considerations. As a result of the series of explosions in the U.S.A., all our furnaces are now situated in reinforced cubicles and operated remotely with all the complications which that involves. But our main problem has been coping with the widely fluctuating level of demand. I don't want to labour this point, but we started 1956 having just reached a melting rate of 1,000 tons per annum. In February, due to cancellations and postponements of [aircraft] orders, this had to be reduced to 250 tons per annum, resulting in a major redundancy in March. In May the target had to be reduced still further, in spite of a heavy stocking policy, which meant that we had to get rid of some of our most skilled operators. By the autumn we were again being pressed for more and more output, which we could not deliver as soon as we would have liked, because of the time taken to train new men. We have already been through several cycles of this kind, and I would ask for your co-operation in doing everything possible to help damp out the oscillations.

Up till now all the wrought forms have been produced on traditional plant designed for other non-ferrous metals or steel—either in our own factories, or on a hire basis. As time went on, it became more and more evident that there was a need for specialized plant, designed solely for titanium, and in October 1955 the I.C.I. Board sanctioned a £3m scheme for a new plant in South Wales designed exclusively for the production of titanium sheet and rod. There is no doubt that the need for such a plant has been appreciated more quickly here than in the U.S.A., and when the sheet side is completed by the middle of this year, and the rod side by the end of the year, it will be the first integrated titanium-fabrication plant in the world.

Our general approach to the problem on rod has been rather different from that on sheet. On rod, we feel sufficiently confident of the process evolved to invest in an automatic mill of the most modern design with roller guides and repeaters with finishing speeds of over 2,000ft per minute. This will be the most advanced mill of its kind in the country and should have sufficient potential capacity to meet demands for many years to come.

On sheet, the position is rather different. Our present production is by discontinuous, single-sheet rolling; and, while a satisfactory product can be produced by this method, there is no doubt that considerable economies could be achieved by continuous strip/sheet rolling. The difficulty is that while commercially pure material can certainly be cold-rolled by this means, it is still very doubtful whether the strong alloys could ever be cold-rolled at all. The indications are that in the U.S.A. (and, we gather, in U.S.S.R. as well) all the strong-alloy sheets are still being hot-rolled singly or in packs.

Our short-term solution has therefore been to install in South Wales two very powerful 4-high single-sheet mills, one for hot rolling and one for cold. At the same time, we are working in collaboration with Shepcote Lane Rolling Mills to develop techniques for strip-rolling the pure material using their Hot Steckel and Sendzimir mills. In the meantime, we are working on the design of plant specifically for titanium.

The question of cast shapes is a difficult one, and we realize that a need for these will undoubtedly arise, which must be met. We do not pretend to be expert in foundry techniques, but none of the casting firms at present have any background in titanium melting, and unfortunately the two operations cannot be separated.

I.C.I. have done a considerable amount of research work on a lip-pouring, scull-melting furnace and the casting of simple shapes in the graphite moulds. It is the present intention to continue with this work, unless it appears that another organization is prepared to put in the very large development effort which would undoubtedly be necessary if any significant progress is to be made.

PRODUCTION OF WROUGHT TITANIUM

By J. R. Crane, Production Mgr., Titanium, I.C.I. Metals Division

SOME of the alloys we are producing are those which have found favour in the United States. All but the softest grades of commercially pure titanium should also now be regarded as alloys, since because of the remarkable reduction in hardness of the raw material from our General Chemicals Division sodium reduction plant, we were forced to develop techniques for hardening by additions of oxygen. The resulting materials are certainly more homogeneous than those produced from the older hard raw materials.

Billet and forged bar products are made by forging titanium ingots; and although the maximum piece-weight from our current 800-lb ingot is of the order of 650 lb, by mid-1958 we shall be melting 1-ton and 2-ton ingots with correspondingly greater maximum billet weights. Billets, bars and slabs can be supplied in the machined condition and all such material is ultrasonically tested before despatch. In all except the very largest piece sizes we can carry out sufficient working of the material to ensure that its properties in the as-despatched condition meet the specification requirements.

We are at present producing rod in diameters down to $\frac{1}{2}$in by hand-rolling techniques, and we supplement our capacity by using that of a steel rolling firm in Sheffield. We can call on ample capacity to meet any requirements which can be envisaged for 1957. Towards the end of this year our Rod Plant at Waunarlwydd will come into operation and we shall then be rolling sizes between 5in and $\frac{1}{4}$in diameter. The smaller sizes of rod will be rolled on a guide mill of Swedish design, the first of its kind to be installed in this country. It will be capable of high output and will produce rod of a high degree of accuracy both in respect of diameter and roundness. At present almost all the rod we sell is in the centreless-ground condition; the Waunarlwydd Plant has centreless grinding and turning capacity to match its rolling capacity.

We have made substantial progress in drawing titanium and its alloys. I.C.I. commercially pure titanium is offered in diameters down to 20 s.w.g., and 317 alloy wire, likely to be needed for welding wire, in sizes at least to 16 gauge. All the other alloys in our range can be supplied in diameters at least to $\frac{1}{8}$in.

Apart from welding wire, the main potential usage of this small diameter titanium rod is in the field of fasteners—bolts, shear pins and rivets. As far as bolts are concerned we know that the Ministry of Supply has organized a programme of work to evaluate the properties of bolts in the 4/4 aluminium manganese alloy. Guest, Keen and Nettlefolds have successfully produced batches of bolts from our 314 A material, and we gather that the preliminary test results have been promising.

We understand that there has been relatively little progress in the titanium rivet field. This appears to be partly due to inability to produce rivets which could be closed cold satisfactorily with conventional equipment and partly due to the difficulties the rivet makers encountered in obtaining material with suitable dimensional tolerances. Wire in the softest grade of Titanium 120, and with suitable tolerances, is now available and should enable further development work to be carried out.

There has been some demand for rectangular, square and hexagonal rod and we think that demand for this type of product may increase. For more complicated shapes we have been carrying out development of the extrusion process with some measure of success.

Plate, sheet and strip are all produced by rolling and we define plate as rolled material with a thickness greater than $\frac{1}{16}$in. In these thicknesses we can offer the whole range of alloys, subject to a maximum piece weight of, for the present, 650 lb. So far there has been little demand for plate, but we understand that there is a possibility of using it for compressor cases and possibly fabricated discs. [*Contd. overleaf*

TALKING ABOUT TITANIUM . . .

In the case of sheet materials below ⅛in thickness, there has been considerable demand—mainly for commercially pure material—and we were asked to build up capacity in this field. During last year we built up, in advance of our Waunarlwydd Scheme, potential capacity for the production of about 250 tons per annum of sheet.

In the early days there was some criticism of our sheet in respect of flatness and gauge tolerances, but for some time now we have been achieving standards of flatness comparable with alloy-steel sheets, and we are offering our 2ft wide material to the S 500 gauge tolerances, i.e., the same as those offered for alloy steel sheet for use in aircraft. As far as formability of our material is concerned (compared with, for example, the equivalent American product) we have heard nothing but praise.

At present we are making some strip in widths up to 24in and gauges down to about 0.018in. In narrower widths, strip is being required for roll forming into structural sections, and we have supplied material for this purpose. There is, in addition, a demand for narrow-width thin strip for the production of honeycomb sections and for heat exchangers. Using our own equipment, and that of certain other firms, we are producing strip in gauges down to 0.0025in, and hope to extend this to 0.001in. Marston Excelsior have been developing techniques for brazing this thin strip. If demand arises for this material we shall increase our capacity and although we are at present only offering it in the various grades of C.P. titanium we do not rule out the possibility of producing strip in some of the stronger alloys.

We can produce tubes in all the four grades of C.P. titanium, but we have concentrated our attention on tube in Titanium 130 because in this composition we can substantially match the stainless-steel tube specification D.T.D. 743 for aircraft hydraulics. The titanium tube meets the appropriate proof pressure requirements and is also capable of being readily bent and shaped and can be flared sufficiently to use the standard couplings. We have every confidence that before long we shall be offering tubing with a fatigue life acceptable to the aircraft industry.

In conclusion, Mr. Crane discussed the possibility of minimizing the total number of material specifications. He asked for suggestions from the aircraft industry. He also touched upon homogeneity; in many specifications I.C.I. had agreed to run no less than four sets of tests per ingot, but they hoped to establish sufficient confidence for the rate to be progressively reduced.

RESEARCH AND DEVELOPMENT

By Dr. N. P. Inglis, Research Director, I.C.I. Metals Division

This paper was by far the longest of any presented at the meeting. Dr. Inglis covered the entire field of titanium research at I.C.I. and made, inter alia, the following points (these are not necessarily verbatim extracts).

APART from the cost of research into production of the metal itself I.C.I. Metals Division are spending a sum of approximately £250,000 a year on titanium research and development.

Extensive fatigue investigations have shown that the ratio of fatigue strength under complete reversals to the ultimate strength is about 0.5 for commercially-pure titanium rising to 0.6 or more for several of the alloys. This high ratio is preserved at elevated temperatures. Work still incomplete suggests that titanium is not unduly peculiar in notch-sensitivity. In addition, the corrosion fatigue performance of titanium is outstandingly good.

Much research has been done on heat treatment and creep strength. Titanium 371 is not sensitive to heat treatment when loaded to less than 25 tons/sq in at 400 deg C; at 500 deg C the total plastic strain after 300 hr at 15 tons/sq in is about 0.1 per cent for the heat-treated condition, and half as much for the annealed condition.

Practical difficulty in producing sheet in alloys heat-treated to approach 80 tons/sq in is considerable, particularly since surfaces and gauge specifications may demand some final cold rolling.

Regarding the joining of titanium, past experience has been largely upon fusion-welding with tungsten arcs shielded by inert gas. Torch brazing has been investigated and furnace brazing, using nickel-copper as a brazing foil, has attractive possibilities. Work is also in hand on the problem of joining titanium to other metals.

Extensive development has led to the evolution of extrusion equipment which should lead to the production of titanium tubing with a much improved surface. Experimental tubes of the quality expected from the new equipment have been taken off test unbroken after two million applications of a pressure of 5,000 lb/sq in.

Much effort is currently being directed towards finding the optimum lubricants for hot extrusion. I.C.I. can see grounds for some optimism in producing satisfactory extruded sections.

CURRENT PROBLEMS OF USAGE

By R. L. Preece, Technical Service Department, I.C.I. Metals Division

OF the semi-fabricated titanium sold by I.C.I. during 1956 a rough analysis splits it into the following five categories: 40 per cent rod for compressor blades; 20 per cent sheet for firewalls; 20 per cent sheet for exhaust and jet-pipe shrouds; 5 per cent billet for discs and spacers; 5 per cent bar for small forgings, fabrications, etc.

The above sub-division does not attempt to differentiate between development programmes and the production programmes. The first category, i.e., the 40 per cent supplied in rod form for manufacture of compressor blades, appears at present to call for moderate-strength material with an ultimate tensile strength of 40-55 tons. The limitations to a more extensive use appear to be those of temperature rather than strength. That is to say, it would be more useful to the aero-engine designer if he could apply the same stress at a higher temperature than he is now able to tolerate and our objective, therefore, should be to extend the useful temperature range by developing suitable alloys with adequate fatigue strength at temperatures of 400 or even 500 deg C. On the other hand, there are already available stronger alloys with strengths in the region of 60-70 tons/sq in and it is possible that the engine manufacturer could to a considerable extent help himself by developing fabrication techniques to deal with these tougher alloys.

In considering the 20 per cent of material supplied as commercially-pure sheet for use in firewalls the demand here seems to be for wider, thinner sheet which can be used in direct replacement of stainless steel. In the majority of cases these firewalls are not highly stressed though design philosophy seems to vary on this point. In some cases the softer grades of commercially-pure material should be adequate, in other cases harder grades such as Titanium 160 appear necessary. At present we are tending to look on a 2ft × 0.010in sheet as a standard production size. We are, of course, making both thinner and wider material, and we should welcome some guidance on whether greater emphasis should be put on increased width (up to say 4ft) or a thinner material (down to say 0.005in).

In considering the material for exhaust and jet-pipe shrouds rather similar remarks appear to apply. A rather greater degree of formability seems to be called for, though once again the stress levels encountered are fairly low. Commercially-pure material seems fully adequate for this demand and it is possible that tighter control of strength ranges will ease some of the problems in fabrication of the shapes called for.

Any appreciable use of titanium-alloy discs and spacers is really awaiting further evaluation by engine designers and manufacturers. The main requirement appears to be creep-resistance and we are actively investigating alternative heat-treatments on alloys such as Titanium 371, so that high creep-resistance can be attained by treatments applicable to relatively thin sections. There may be some difficulty associated with forging such tough alloys to the required thinness. We understand the forging industry will be doing its own development work in this direction but think there is a possibility of using welding as an assembly method. In this direction it is possible that the considerable experience of Marston Excelsior (a subsidiary company of I.C.I.) may be of some help to the industry.

The material briefly described as bar for small forgings, fabrication, etc., covers a multitude of jobs. Many firms up and down the country appear to have overcome the difficulties of making small drop-forgings and to appreciate the necessity for control of contamination both by hydrogen and oxygen during pre-heating.

Rivets are becoming available both in commercially-pure material and in alloys such as I.C.I. Titanium 314C, though it is apparent that development work is still needed before these rivets can be set in actual aircraft structures. It would be possible to make suitable use of these rivets, however, in lightly stressed areas such as firewalls and heat shields. Bolts have been made in Titanium 314A which appear comparable with steel bolts in fatigue characteristics. Work is also in hand to make similar bolts in Titanium 318A which holds out prospects of even higher strengths. Hi-shear pins are becoming available in small quantities in Titanium 314A. The experience of users is still needed.

A considerable amount of commercially-pure titanium is being used in sheet-metal work, such as hot-air ducting and cannon blast tubes, and much work has been done on evolving welding techniques. Here again Marston Excelsior can offer excellent facilities for such jobs. There is still much development work to be done on the use of the stronger sheet alloys such as Titanium 317 and Titanium 318A which are now becoming available. This titanium strip or foil is being made available for sandwich structures and development work is well advanced in brazing techniques. There is still difficulty in devising a simple inspection technique to estimate what contamination, if any, has occurred during welding or brazing.

(*Concluded on page 284*)

RANGE OF COMMERCIAL TITANIUM AND TITANIUM ALLOYS IN PRODUCTION

I.C.I. Code Number	Nominal composition	Forms available	Mechanical properties			Future range of mechanical properties		
			1% P.S. (tons/sq in)	U.T.S. (tons/sq in)	Elongation (per cent)	1% P.S. (tons/sq in)	U.T.S. (tons/sq in)	Elongation (per cent)
120	Commercially pure	All forms	—	30 max.	20 min.	—	30 max.	20 min.
130			18 min.	25–40	15 min.	18 min.	28–40	15 min.
150			25 min.	35–50	15 min.	—	—	—
160			30 min.	40–55	15 min. (rod) 12 min. (sheet)	30 min.	40–52	15 min. (rod) 12 min. (sheet)
314C	2% Al, 2% Mn	Billet, bar, slab, plate, rod, wire	30 min.	40–55	15 min.	30 min.	40–52	15 min.
314A	4% Al, 4% Mn		57 min.	62 min.	10 min.	—	No change	—
317	5% Al, 2½% Sn	Billet, bar, slab, plate, sheet, rod, wire	49 min.	53 min.	10 min.	—	No change	—
371	13½% Sn, 2½% Al		50 min.	60 min.	10 min.	—	No change	—
318A	6% Al, 4% V		58 min.	62 min.	10 min.	This alloy may become available in heat treated forms with U.T.S. and P.S. higher than those quoted.		

The Air Traffic Control Problem

Britain's Overloaded A.T.C. System at Work

By J. H. GROVER, M.I.N.

PERHAPS the greatest significance of the Guild of Air Traffic Control Officers' Convention at Southend last October [*Flight*, October 12] was the way in which the spotlight was turned upon the deficiencies in the United Kingdom air traffic control system. What made the matter even more significant was the fact that the control officers themselves were wielding the spotlight. Quite a considerable volume of matter was written about this convention, both in the technical and lay Press, and there is no point in going over the ground again in any detail. It suffices to say that the A.T.C.O.s themselves admit that the system is dangerously close to breaking down, mainly owing to the limitations inherent in the human character; and it is the purpose of this article to examine the A.T.C. system as it is today, and to discuss its weaknesses and possible solutions to its problems.

Air Traffic Control Structure. Before proceeding further let us, very briefly, consider exactly what A.T.C. represents. The definition of air traffic control is usually quoted as being ". . . to promote the safe, orderly, and expeditious movement of all aircraft." It will be obvious from this that the term is somewhat elastic, and it will be found that the control service covers practically all aspects of flying. Thus, under the general heading of "Air Traffic Control" we have the following sub-headings:—

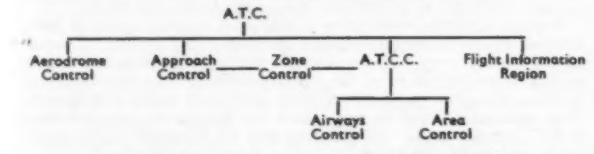
Aerodrome Control: That part of A.T.C. responsible for the implementation of A.T.C. within the circuit of an aerodrome, including surface movements.

Approach Control: That part of A.T.C. responsible for flights arriving at, or departing from, an aerodrome under "Instrument Meteorological Conditions." (I.M.C. is the new "simplified" way of saying I.F.R. Similarly, V.F.R. has been "simplified" to V.M.C. These new terms, which came into effect on December 1, would appear to bear the imprint of those who "simplified" the phonetic alphabet—but all this is another story!)

Airways Control: That part of A.T.C. responsible for the control of one or more airways.

Area Control: That part of A.T.C. responsible for A.T.C. implementation within a Control Area, under I.M.C.

Zone Control: A.T.C. in a control zone, normally provided by the approach control of the main aerodrome within the zone.



Structure of air traffic control in the United Kingdom.

It is not, one feels, necessary to deal in any detail with aerodrome and approach control, although a word or two in explanation of controlled airspaces may be of value. Altogether there are four main types of controlled airspace, all falling within the definition "An airspace of defined dimensions within which air traffic control service is provided to I.F.R. (I.M.C.) flights." These are as follows:—

Control Zone: A controlled airspace extending upwards from the surface of the earth.

Control Area: A controlled airspace existing upwards from a specified height above the surface of the earth—for example, an airway.

Airway: An airway is a controlled airspace that normally extends from 3,000ft to 11,000ft, in the form of a corridor 10 n.m. in width. An airway either connects specific control zones or areas, or provides an exit/entry path to same; it is, in fact, a control area itself.

Terminal Control Area: A portion of a control area normally situated at the confluence of airways in the vicinity of one or more major aerodromes.

In the case of a control zone, A.T.C. is provided by approach control. In control areas, airways, and terminal control areas A.T.C. is provided by an air traffic control centre.

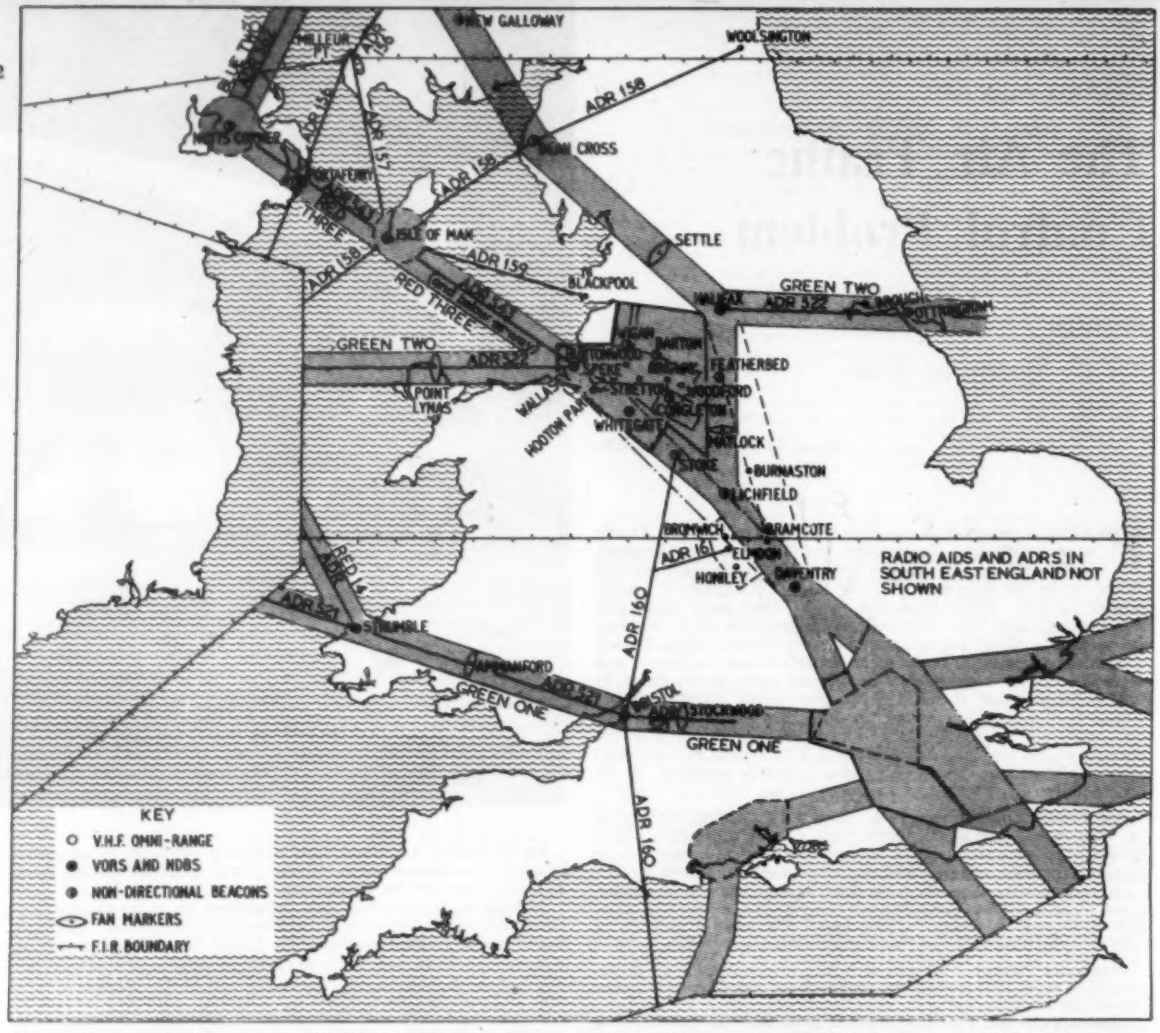
Having dealt thus with basic definitions, let us turn to applications of these different types of controlled airspaces. The first example that springs to mind is the London Area. This consists of a terminal control area, the lower limit of which is 1,500ft, enclosing a control zone. The upper limit of both terminal control area and control zone is 11,000ft. Converging on to this complex controlled airspace are a number of airways, extending from 3,000ft to 11,000ft. Overleaf a general idea is given of the layout. (An exception to the previously given allocations of A.T.C. responsibility may be made in this case in that the London Control Zone may be controlled from the air traffic control centre instead of by approach control.) The London Terminal Control Area is the only control area in the United Kingdom, although there are seven other simple control zones, viz., Scottish, Belfast, Isle of Man, Manchester, Birmingham, Southampton and Channel Islands. The upper limits of some of these are somewhat lower than that of the London Zone, while in the case of Airways Green 1 and Red 14 the upper limits are 17,500ft and 17,000ft respectively.

Forming an integral part of the A.T.C. structure are the Advisory routes. These are roughly similar to airways as regards the services provided but are not in themselves controlled airspaces. Pilots using advisory routes do so at their own option, and all control is of an advisory nature only. Obviously, as these are free airspaces, aircraft other than those known to A.T.C. may be flying in, or near to, the route. Whereas the airways are marked with a system of radio aids, the advisory routes do not necessarily have any aids at all.

A.T.C. Procedures and Aids. Having thus discussed the A.T.C. system in general and somewhat elementary terms let us now consider how the set-up is implemented in respect of actual flying procedures. For this purpose it is convenient to consider a flight operating under A.T.C. authority as consisting of three separate phases: (1) the outbound section, from take-off to the departure from the Control Zone; (2) the *en route* flight along the airway(s); and (3) the approach and landing.

It is not proposed to describe actual procedures in detail as this would entail a complete article in itself. But it is pertinent that they should be referred to in general terms, and perhaps the London Control Zone and Area form the best example.

For A.T.C. purposes the London Zone and Area are divided into a number of sectors, one of which is entirely responsible for the control of outbound aircraft until they reach a point after take-off when the appropriate sector for their route takes over. The first essential for an outbound flight under A.T.C. is for the pilot to file a detailed flight plan with A.T.C. and to obtain a provisional clearance. Depending upon the direction of the



The recently revised airways system for Central England, showing principal radio aids. The South-Eastern area is illustrated opposite.

THE AIR TRAFFIC CONTROL PROBLEM . . .

runway in use and the density of traffic this clearance will specify the route to be followed.

In addition to the route the clearance will also allot an altitude for each leg of the exit procedure. Thus, for an aircraft leaving London Airport with Runway 28 in use, and bound for the north along Airway Amber Two, the normal clearance would be *via* Kilburn (the intersection of the S.E. leg of Watford Range and the N.E. leg of Epsom Range), thence to Brookmans Park non-directional beacon (N.D.B.) and thence to Woburn fan marker. The aircraft will probably be required to inform A.T.C. by R/T when over Kilburn, and usually will do so when over Brookmans Park. Woburn fan marker is a designated reporting point, and indicates to the terminal area control that the aircraft has left the control area.

A feature of the London Control Area is the fact that outgoing traffic is guided through the inbound traffic by the sector controller, using radar, from the moment the aircraft leaves the runway. Aerodrome control, of course, is responsible for all movements of the aircraft on the ground, and for passing take-off instructions and clearance.

After clearing the control area, and if flying along an airway, the aircraft comes under airways control. If the route takes it through free airspace, however, the air traffic control centre acts in an advisory capacity. Once under airways control the aircraft is, by means of frequent position reporting, kept under close surveillance by A.T.C. For an aircraft flying airways the rule of the air is, of course, keep well to the right of the centre line, and a system of radio aids is provided to assist pilots to achieve this object.

However, present-day radio systems in actual use, with one exception, are insufficiently accurate to rely on implicitly, and thus certain safety precautions are taken by A.T.C. to prevent mid-air collisions. Thus, in the control instructions to aircraft, certain requirements are included to prevent them from approaching each other too closely. These precautionary instructions are referred to as separations, and in-flight separation between aircraft may take one or more of several forms. It is worth while detailing these separation standards, which are as follows:—

Vertical Separation: A minimum separation in altitude of 1,000ft.

Lateral Separation: (a) By means of a radio range, aircraft flying well to the right of the range beam; (b) quadrantal separation, using a radio aid, aircraft flying in differing quadrants of the aid; (c) position reports; (d) diverging headings, where the headings diverge by 45 deg. or more; (e) flight along different, accurately determined tracks.

Lateral separation warrants a full paragraph to itself, if only because of the economic aspects involved. The system is based on the time interval between aircraft passing a given point, taking into account the tracks of the aircraft, whether they are climbing or descending, airspeed differentials, and other associated factors. The separation basis is time, and the various separations that A.T.C. employ under this heading may be tabulated for convenience and clarity, as below:—

Aircraft on the same track and altitude: Five minutes if airspeed differential at least 20 kt in favour of leading aircraft. If less than 20 kt the separation is 10 minutes.

Aircraft on crossing track at same altitude: Ten minutes' separation, or more at discretion of the controller.

Aircraft on same track, in same direction, climbing or descending: Five minutes at the time the levels are crossed, or more at the discretion of the controller.

Aircraft climbing or descending on the same track in opposite directions: If lateral separation is provided, not required. If no lateral separation vertical separation will be employed for at least 10 minutes before and after aircraft are estimated to pass, this separation to be cancelled if the aircraft are reported to have passed within the time limit.

Departing Aircraft: One minute if the aircraft are to fly different tracks and lateral separation is to be employed from take-off. Vertical separation of 1,000ft or longitudinal separation as detailed above. If, on reaching a designated reporting point within or near a control zone or terminal control area, the tracks of two outbound aircraft diverge by more than 30 deg, or if vertical separation be provided after the reporting point, the longitudinal separation may be reduced to five minutes up to the reporting point.

Horizontal separation depending upon the use of radar is also employed, and the standard separation between aircraft that have been identified on the radar screen and other aircraft on the screen which have not been identified is five miles. This separation is the distance between vertical lines passing through the aircraft measured in the horizontal plane in any direction, the minimum distance between aircraft echoes thus being five miles. (In all cases the nautical mile is used.) In the Prestwick-Shannon Oceanic Control Area, incidentally, no horizontal separation is employed. Instead, a lateral separation of 120 n.m. and longitudinal separation of 30 minutes is used, but it must be remembered that no really accurate navigational aids exist which permit the reduction of these standards in this extremely busy airspace.

So much, then, for the separation standards employed. Apart from the Oceanic Area Control Area, flight within the U.K. controlled airspaces is subject to the carriage by the aircraft of a certain minimum scale of radio and navigational equipment. It is necessary for the aircraft to be able to communicate with all the appropriate A.T.C. authorities and to be able to determine its position accurately enough to comply with A.T.C. requirements for the implementation of the foregoing separations. The carriage of certain additional radio-navigation equipment permits the reduction of these standards between aircraft so equipped (of which more later).

We come next to the approach and landing phase of a flight. To a very limited extent this is the outbound procedure in reverse, although far more critical. Naturally, the governing factor is the speed with which aircraft can be guided down to and cleared from the runway; and the guiding A.T.C. principle is to try to achieve a regular landing flow, with the minimum time interval.

To do this, aircraft approaching the control zone or area usually make for a designated radio aid, and not the aerodrome in question. To take again the example of London, inbound aircraft are given a point of entry into the terminal control area, together with an altitude. The aircraft, in turn, supplies A.T.C. with a regularly amended E.T.A. at this point. From the entry point the aircraft is then directed to a holding point, marked by a radio range, and is instructed to hold at a given altitude.

This involves flying a holding pattern at a constant altitude; other aircraft may be holding both above, or below, forming the holding stack. It is the function of approach control to call the lowest aircraft from the stack as the aerodrome runway becomes clear of preceding aircraft. As each aircraft is thus picked off from the stack the others holding above drop down one place, and a continuous landing flow is achieved. For example, an aircraft making for London Airport from the south-west along Airway Red One may be required to report to A.T.C. at either the fan marker at Haslemere or at the radio range station at Dunsfold. Dunsfold is itself a designated reporting point, while Haslemere is "on request." From Dunsfold the aircraft joins the holding stack at the range at Epsom.

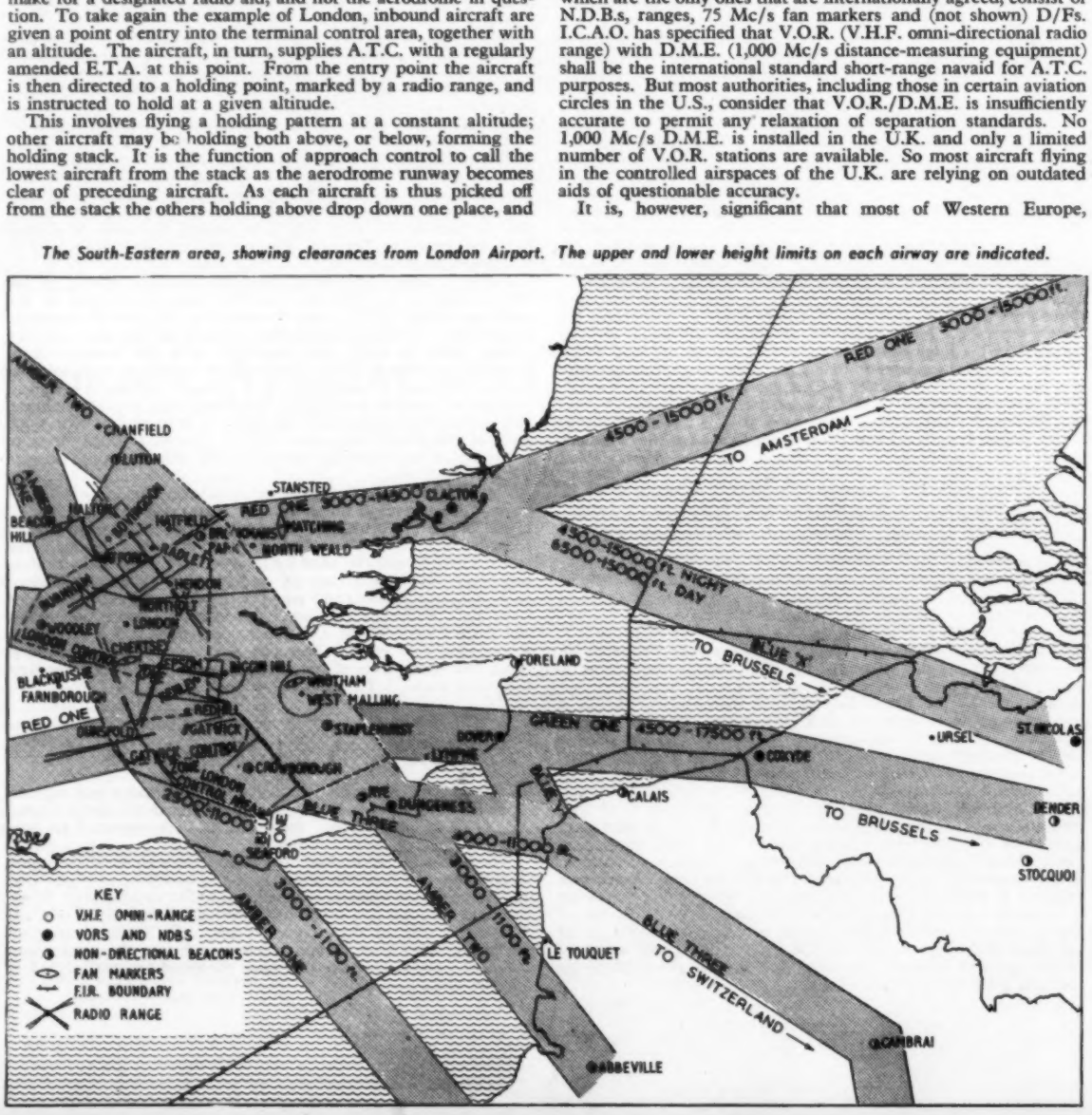
Air Traffic Control Problems. It may be stated quite clearly and simply that the greatest single problem facing A.T.C. is the ever increasing danger of air-to-air collision—the direct result of the continuous increase in the volume of air traffic. The present control system cannot cope with any increase in traffic without reducing separation standards. And unless new rules concerning radio-navigational equipment are internationally agreed and enforced any such reduction is nothing short of a reduction in safety. What exactly, then, is the limitation?

Briefly, the available controlled airspace is saturated with traffic, to the limitations dictated by the performance of the available internationally agreed radio aids. This problem is confined essentially to the *en route* phase, where radar surveillance is not normally available. Therefore, the only other method of protecting aircraft from the collision risk is to employ the undoubtedly restrictive separations previously described—which is, of course, limiting the development of air transport. Although the landing rate must always provide the final limitation there is reason to believe that this point has not been reached yet.

We must therefore examine the *en route* section more closely. The whole problem revolves here around the accuracy with which each and every aircraft is able to notify its position as and when required, and the delay likely to be experienced while this is being done. Referring once more to the maps, the radio aids shown, which are the only ones that are internationally agreed, consist of N.D.B.s, ranges, 75 Mc/s fan markers and (not shown) D/Fs. I.C.A.O. has specified that V.O.R. (V.H.F. omni-directional radio range) with D.M.E. (1,000 Mc/s distance-measuring equipment) shall be the international standard short-range navaid for A.T.C. purposes. But most authorities, including those in certain aviation circles in the U.S., consider that V.O.R./D.M.E. is insufficiently accurate to permit any relaxation of separation standards. No 1,000 Mc/s D.M.E. is installed in the U.K. and only a limited number of V.O.R. stations are available. So most aircraft flying in the controlled airspaces of the U.K. are relying on outdated aids of questionable accuracy.

It is, however, significant that most of Western Europe,

The South-Eastern area, showing clearances from London Airport. The upper and lower height limits on each airway are indicated.



A.T.C. in operation—controllers in the tower at Renfrew, Glasgow, which also forms the subject of the heading illustration on page 271.

THE AIR TRAFFIC CONTROL PROBLEM . . .

including the U.K., is covered by two area-coverage navigational aids of very great accuracy. These are Gee and Decca. The former, although meeting the accuracy requirement, has failed to find favour with most operators due to the presentation and need for "operation" each time a position is required. This involves referring an indicated reading to a special chart, and although the resulting fix is accurate to within a matter of yards the system has not been approved for reduction of existing standards of separation, due no doubt to the non-self-evident, non-continuous, cathode-ray-tube type of presentation.

Decca, on the other hand, when equipped with Flight Log presentation, almost completely meets the A.T.C. requirement for relaxing present separation standards. It is by now well known that the official U.K. view is that the basis of the A.T.C. procedures in this country shall be Decca, and that reduced separation standards shall be available to Decca-equipped aircraft. Notam 545 of July 31, 1956, established these new principles, the carriage of the Flight Log type of continuous pictorial-tracking presentation being a condition. These separations are based on the fact that Decca-equipped aircraft may fly prescribed tracks with very great accuracy, and at the same time be able instantly to read off a position report as required. Thus a requirement for lateral separation is satisfied, the Decca aircraft being able to fly airways keeping well to the right of the centre line at all times. Even Decca aircraft flying the same airway on opposite headings can rely on an approximate separation of 10 n.m. as they pass each other. In the case of the London Control Area special Decca entry points have been designated. Known as Decca points J, A, B, G and R these are located at the Southern and Eastern boundaries of the London FIR and Airways Red One, Amber One, Amber Two, Green One and Red One respectively. Aircraft with Decca report to A.T.C. when over these points, or give their E.T.A. at these points. Using Decca, aircraft flying the same and opposite headings are permitted to climb and descend through each other's altitude on parallel tracks, effective lateral separation being achieved through the use of this aid.

Considerable distortion is sometimes seen as a characteristic of the Flight Log chart, depending upon the Decca radiation pattern upon which it is drawn. But orthomorphism is not a requirement, for the chart is not intended to be used for map-reading, but to provide a continuous display of position and to facilitate accurate track-keeping. Just as the Mercator plotting chart is distorted in order to provide a simple rectilinear graticule based on a sphere so the Flight Log chart is distorted to provide a rectilinear graticule from a hyperbolic pattern. In each case the orthomorphism suffers; the characteristic of a Flight Log chart is that a hyperbola takes the form of a straight line, while the scale varies over the surface of the chart. But by superimposing tracks and geographical locations, together with radio facilities and controlled airspaces, and the like, this inherent distortion is of little account, provided that due allowance is made for the pattern upon which the chart has been constructed. The track from, say, Ferryfield to London Airport could not be conventionally drawn in by means of a ruler; but assuming this particular track was required it could easily be superimposed by first of all drawing it in on an ordinary Decca conical plotting chart. A number of Decca lattice co-ordinates would then be taken at intervals along the track and these plotted on the Flight Log chart from the Decca graticule included thereon. By linking these plots the required track may be drawn in.

It may be seen that the real problem facing A.T.C. is to permit the natural growth of air traffic while at the same time retaining acceptable standards of safety. The U.K. has shown that a suitable means exists by which this object can be achieved. But its effect can only be really felt when all aircraft flying under A.T.C. rules can make use of the same facilities. At present Decca represents the existing answer to the problem of airspace utilization; the bold step now would be for the authorities to make its use mandatory.

Plans and Possibilities. From the foregoing a general idea will have been obtained of the air traffic control structure in the U.K., the way in which it works, and the problems facing it. In conclusion, let us examine some of the alleged weaknesses of the system, and discuss briefly some means by which these weaknesses may be removed, or at least minimized.

In the considered opinion of the writer a possible weakness of the United Kingdom A.T.C. system may lie in the fact that it is a public service. The answer, it is submitted, might be to disestablish the A.T.C. organization from the Ministry of Transport and Civil Aviation and to place it on a similar footing to its marine counterpart, Trinity House. After all, civil air transport is often referred to as the merchant service of the air.

Again, although we have discussed the Decca system, and have shown how it permits the reduction of separation standards, the need is still apparent for some additional aid that will guard against possible collision in mid-air. Various devices are under development, but few of these provide sufficient information.

In the view of the writer the ideal might be for the pilot to be provided with a pictorial representation of the traffic situation within a radius of some 30 n.m. of his actual position. This could be achieved fairly simply by a combination of secondary ground radar and television. If every aircraft were compelled to carry a small transponder, weighing but a few pounds, and all controlled airspaces were covered by ground surveillance secondary radar every aircraft flying within the range of the radar stations would be easily detected and identified by virtue of the coded replies from the airborne transponders, each aircraft emitting its own particular code reply. Assuming, now, that the ground radar screens were televised and continuously broadcast on separate radio channels a small, light television receiver on board aircraft requiring the use of the aid would be able to provide the pilot with a picture of the airspace around him, showing him not only his aircraft but any other aircraft within range as well.

There is also a school of thought, especially strong in the United States, that believes that the answers to most of the problems facing A.T.C. may be solved by the use of electronic computers. Certainly the position is becoming too hectic for the human mind to deal with, especially with the imminence of turbojet operations. The introduction of short and medium haul jet airliners in any quantity is going to call for a complete revision of control procedures, involving high altitude holding, and accelerated climbs and descents. It may well be that some form of completely automatic A.T.C. system, feeding direct to the autopilot by means of a radio link and couplers, could provide the answer.

Finally, just to confirm the views expressed at Southend, let us listen to the views on this subject expressed in the House of Lords on November 28 of last year. Lord Ogmore, a former Minister of Civil Aviation had, in the course of a debate, urged on the Government the need for improved international air safety measures. He stated that air traffic and the risk of collisions were increasing daily, and supported this by figures. Although there had been only two accidents from this cause during the last eight years in the U.K. there had been 324 near misses in the past two years. This last fact alone perhaps serves to bring the seriousness of the matter home more effectively than the views of the A.T.C.O.s at Southend.

PALOUSTE ENDURANCE TEST

THE 134th Turboméca Palouste IV gas generator was recently subjected to a repeat type-test and endurance test under French Air Ministry observation, from which it is reported to have emerged "successfully."

The original type-test had been completed with the 75th engine. Engine No. 134 was run under type-test conditions for just over 167 hours by the makers, stripped and found satisfactory. It was then put through two consecutive periods of 165 hr 37 min and 172 hr 33 min in the Ministry's test cells without stripping. Including some 8 hr 50 min of running before these tests were made, the engine is stated to have completed a total of 514 hr 42 min without trouble.

Camera Artistry in Coastal Command

THE photographs displayed on this and the next two pages are selected from entries in a photographic competition held between the units of R.A.F. Coastal Command. Obviously the judging of Service pictures cannot be based on ordinary standards, and for that reason the photographs reproduced here have been selected chiefly for their spectacular and artistic value and suitability for reproduction. They are not all prize-winners; but where an award has been gained this is noted in the caption. Of the 16 competing squadrons, Nos. 224 (Gibraltar), 269 (Ballykelly) and 36 (Topcliffe) were placed first, second and third respectively. In the inter-station section of the contest, first place went to North Front (Gibraltar) and Topcliffe was placed second, with

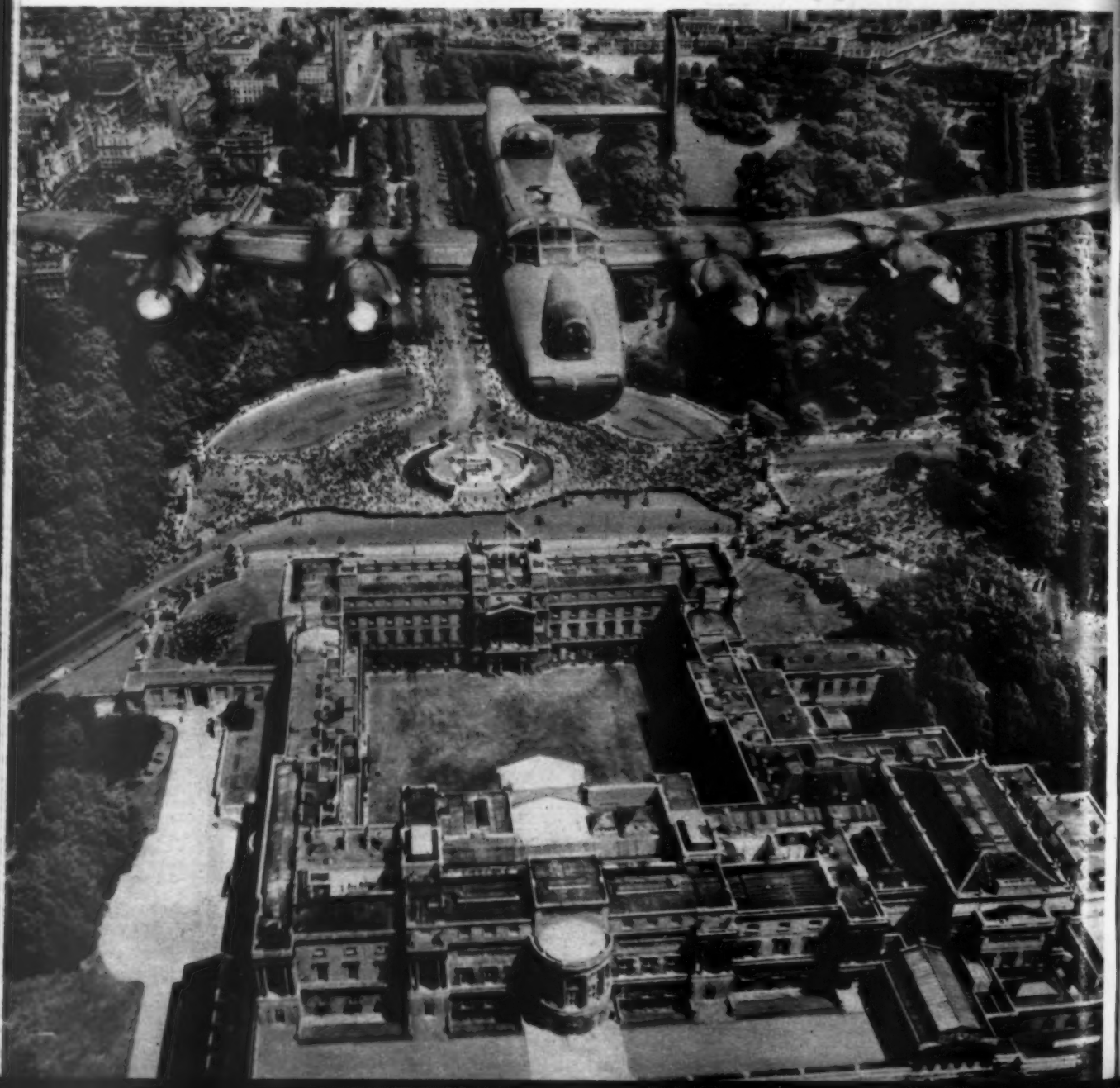
(Above) EVENING PATROL: Sgt. H. J. Western, No. 269 Squadron; first award, air-to-air.

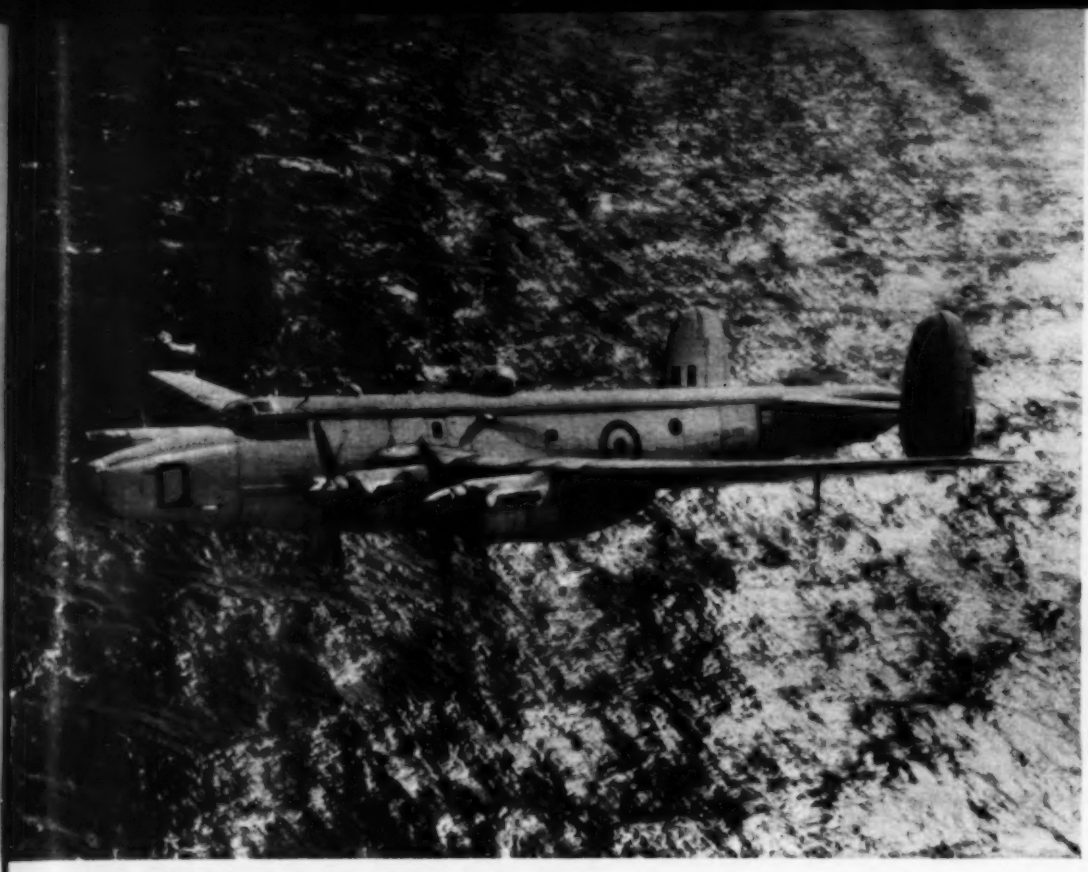
(Right) TRAFALGAR LIGHTHOUSE: Sgt. C. Smitham, No. 224 Squadron; first award, air-to-ground.

CAMERA ARTISTRY IN COASTAL COMMAND . . .

H.M.S. BRITANNIA: Sgt. Crook, No. 224 Squadron; exhibition print.

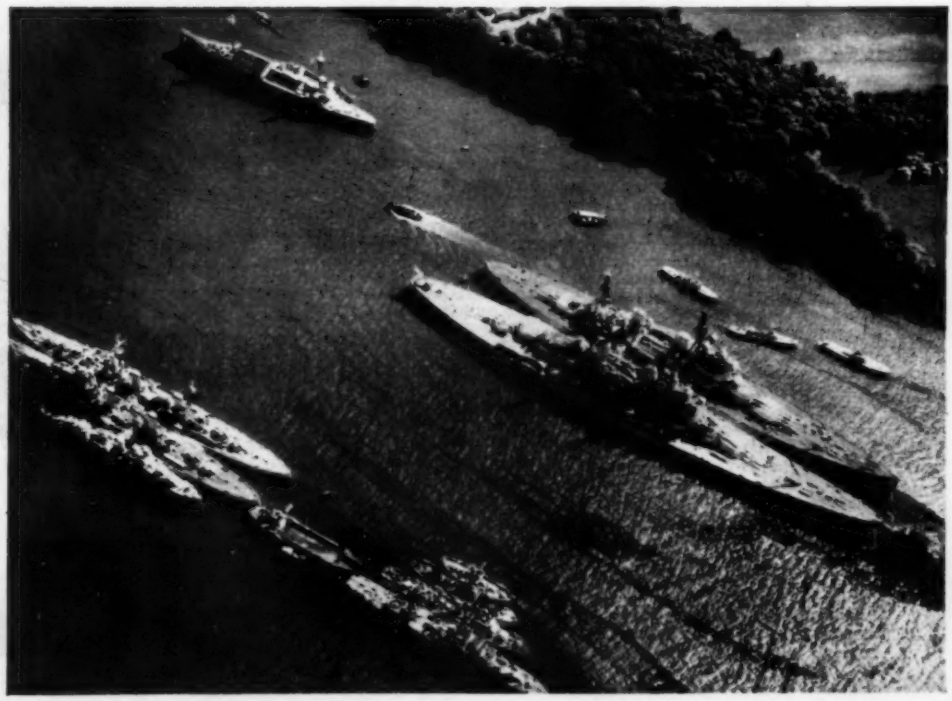
(Below) BUCKINGHAM PALACE: F/L. Jepson, No. 228 Squadron; exhibition print.





H.Q. Unit Coastal Command and St. Mawgan tying for third. Though the general standard of photography displayed was quite high it must be said that some of the exhibition prints lacked finish. In Service photography there are, of course, handicaps to be overcome; in particular, the processing staff never see the conditions obtaining at the time the pictures are taken, and conversely, the aircrew usually have no part in the subsequent processing. An interesting aspect of this competition is the manner in which it illustrates the vast scope of Coastal Command's activities. The geographic locations of the pictures displayed in the exhibition at the Northwood H.Q. range from Jan Mayen Island in the north to the Sydney Harbour bridge in the south. Photographs from Ceylon mark the eastern limits and Bermuda the west. All the photographs were taken during 1956. Trophies are to be presented to the winners next month at North Front, Gibraltar, by Air Marshal Sir Bryan V. Reynolds, K.C.B., C.B.E., A.O.C-in-C. Coastal Command.

(Above) SHACKLETON WL753: Sgt. Newton, No. 224 Squadron; exhibition print.



FLEET AT ANCHOR: F/Sgt. Bladon, No. 42 Squadron; first award, air-to-sea.

The uppermost view shows how the Bell Rascal air-to-surface missile (range 100 miles) is carried by a Boeing B-47. The second picture is of the Bréguet 1050 Alizé anti-submarine aircraft, powered with a Rolls-Royce Dart RDa.7 driving a four-blade Bréguet BR.4 propeller (Rotol licence).

pending the time when the solution of the long-range ground-to-air missile "(entirely irretrievable) will be economically feasible."

Leduc 022. This single-seat supersonic ramjet research aircraft has now made fifteen flights on the power of its S.N.E.C.M.A. Atar turbojet (without afterburner). Tests of the ramjet should be under way next month.

Denmark

Hunting Percival Pembroke. Delivery of

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(Above) SHACKLETON WL753: Sgt. Newton, No. 224 Squadron; exhibition print.

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BELOW SQUADRON STATUS

Auster A.O.P.6 of No. 1960 Flight.

*An Outline History of R.A.F. and F.A.A. "Flights"—Part 2**

By R. C. STURTIVANT

AS the 1400 series came to a close, in 1942, the 1500 series and 1600 series began. It must be realized, however, that the numbers were not always used in sequence. Reservation of blocks for specific types of units resulted in new units having several possible numbers. Another factor was that, in accordance with the policy of avoiding duplication of unit numbers, no flights were given numbers corresponding with those of Conversion

or five Hudsons at Chaklala. Commanded by F/L. J. King, it divided its time between dropping agents deep in Burma and helping to train supply-droppers at Chaklala. It was eventually redesignated 357 Sqn.

No. 1577 Airborne Experimental Flight served at Mauripur, Dhamial, and Chaklala and in Southern India. Two calibration Flights were numbered 1580 and 1583. No. 1580 formed at

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AIRCRAFT INTELLIGENCE

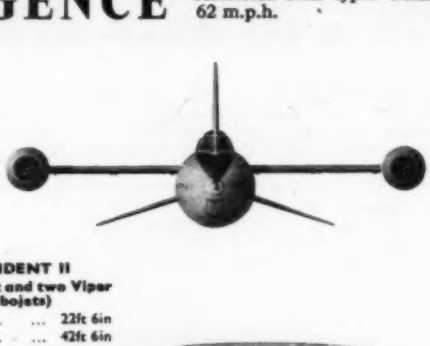
U.S.A.

Boeing B-47E Stratojet. Major Wendell L. Stultz, a U.S.A.F. pilot who flight-tested the first B-47A Stratojet more than six years ago, accepted the last B-47—a model E—at Marietta on February 15. He remarked that one of the outstanding improvements in the B-47 since his first flight has been the installation of "comfortable ejection seats".

Republic F-84. Production of the F-84 series by the Republic Aviation Corporation is now in excess of 7,600 aircraft, 4,457 of which were straight-wing Thunderjets, which have now logged three million hours. Flight time for the swept-wing F-84F Thunderstreak is in excess of 500,000 hr, and the RF-84F Thunderflash has passed the 100,000 hr mark.

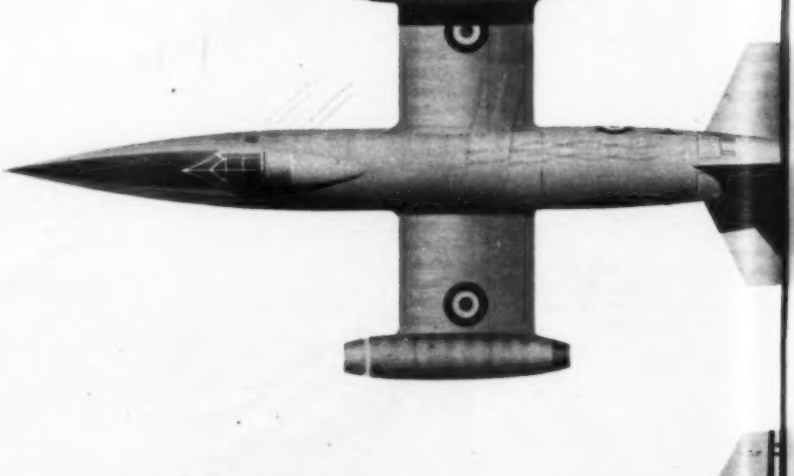
France

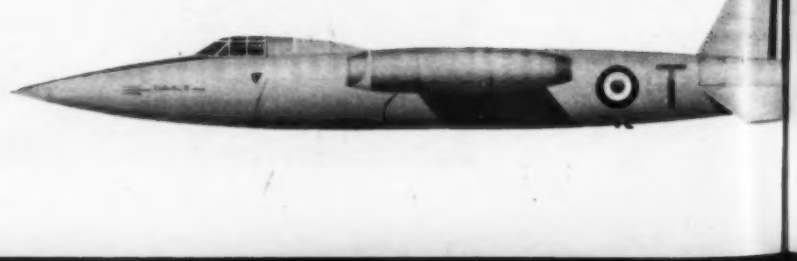
Ouest-Aviation Developments. This item of news is contained in a recent publication by Ouest-Aviation: "Following on the tracks of the Vautour, a twin-jet prototype designed to break through the heat barrier is being developed by Ouest-Aviation. Characterized by a considerable range and a highly perfected radar equipment, this far-striking fighter will be, like its predecessor, liberated to the greatest extent from the bondage of cumbersome ground installations. Able to carry a powerful atomic weapon without any alteration of its performance, the new fighter is apt to become a formidable attacker." Of the Trident mixed-power intercepter the publication remarks: "This light intercepter . . . has already reached an advanced stage of automatic operation. The next phase will be the elimination of the pilot and operation by means of remote control which, for obvious reasons of economy, will bring the aircraft back after it has launched its missile. The final development of the Trident—which no longer needs a long runway—may well be the vertical-take-off formula. It may be necessary to pass through this stage pending the time when the solution of the long-range ground-to-air missile (entirely irretrievable) will be economically feasible."



S.O.9050 TRIDENT II
(One SEPR rocket and two Viper MD.30 turbojets)

Span	22ft 6in
Length	42ft 6in





Leduc 022. This single-seat supersonic ramjet research aircraft has now made fifteen flights on the power of its S.N.E.C.M.A. Atar turbojet (without afterburner). Tests of the ramjet should be under way next month.

Denmark

Hunting Percival Pembroke. Delivery of six Hunting Percival Pembroke C.52/2 aircraft for the Royal Danish Air Force is now complete. They were ferried to Copenhagen *via* Southend, except for the second and third aircraft, which cleared through Bovingdon.

Norway

Norwegian Helicopter. Built in Norway "with the help of the Norwegian Air Force", a new type of helicopter has recently been demonstrated. It is reported to cost less than half the equivalent American-built type. Maximum speed is 62 m.p.h.

BELOW SQUADRON STATUS

Auster A.O.P.6 of No. 1960 Flight.

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AS the 1400 series came to a close, in 1942, the 1500 series and 1600 series began. It must be realized, however, that the numbers were not always used in sequence. Reservation of blocks for specific types of units resulted in new units having several possible numbers. Another factor was that, in accordance with the policy of avoiding duplication of unit numbers, no flights were given numbers corresponding with those of Conversion Units, i.e., 1331/1336, 1380/1385, 1584, 1651/1675 and 1699. Moreover, even where numbers were allocated in sequence, the delay between conception and realization often resulted in some numbers being taken up apparently out of turn.

The 1500 series started as a continuation of the 1400 series, 1508 being an acclimatization flight, aircraft being coded "UQ." Then came a large block reserved for beam approach training flights and, later, radio-aids training flights. These were all equipped with Oxfords, carrying yellow-triangle identification markings. The majority of these units were attached to a larger training unit, such as a (pilot) advanced flying unit, and in some cases originated as part of one. Latterly, some of these units had their Oxfords supplemented by Ansons. Amongst the longest-lived of wartime units, the last of these flights did not close down until 1947. Such B.A.T. and R.A.T. Flights as survived in the post-war period adopted the code markings of the particular Command in which they served. These flights included 1509 B.A.T. Flight at Dyce (1942); 1510 B.A.T. Flight at Leuchars (1941) and Bircham Newton (1947—code "RF"); 1511 B.A.T. Flight (1946—code "FKA"); 1513 R.A.T. Flight with 1381 T.C.U. at Bramcote (1945/6—code "LL"); 1514 B.A.T. Flight at Coningsby (1943); 1516 R.A.T. Flight at Snaith (1946—code "QW"); 1517 B.A.T. Flight at Chipping Norton with 6(P)A.F.U. (1943); 1518 B.A.T. Flight with 8 S.F.T.S. at Edzell (1944); 1521 R.A.T. Flight (1946—code "J6"); 1523 B.A.T. Flight at Great Rissington; 1525 B.A.T. Flight at Docking (1944/5); 1527 B.A.T. Flight at Prestwick (1945), later an R.A.T. Flight (code "PY"); 1528 R.A.T. Flight at Wittering (code "YM"); 1529 R.A.T. Flight at St. Mawgan (1944/5—code "GL"); 1531 B.A.T. Flight with 12(P)A.F.U. at Cranage (1944); 1532 B.A.T. Flight with 15(P)A.F.U. at Babdown Farm (1943); 1537 B.A.T. Flight at Little Rissington (1946—code "FKD"); 1542 B.A.T. Flight with 14(P)A.F.U. at Dallachy; 1546 B.A.T. Flight with 20(P)A.F.U. at Kidlington, Weston-on-the-Green and Snitterfield (1943/4); 1547 B.A.T. Flight with No. 1 Beam Approach School at Watchfield (1945/6—code "FKF"); 1552 B.A.B.S. Flight or R.A.T. Flight at Membury and Wratting Common (1945/6—codes "ER," "PN" and "SS"; aircraft SS-J to SS-M detached to Merryfield); 1555 R.A.T. Flight (code "DR"); 1556 R.A.T. Flight (1946—code "VT"); and 1557 R.A.T. Flight (1946—code "AB").

Sequence Resumed

The normal sequence was then resumed with a block (Nos. 1561 to 1566) allocated to a further series of Met. Flights. Nos. 1561 and 1562 were based in the United Kingdom, being coded "VM" and "B9" respectively, whilst the remaining four served in the Far East, 1565 Met. Flight having Hurricanes and the other three Gladiators. Nos. 1563 and 1564 Flights were attached to 212 Group in North Africa in 1942/43, 1563 Flight eventually receiving Spitfires (Mk 5B and 8). No. 1565 Met. Flight formed part of 259 Wing in the Levant, whilst 1566 Flight came under H.Q. British Forces, Aden, and was stationed at Hiswa. The remaining flights in the 1500 series were formed in the Middle East and Far East, the majority of them in India. Three ground gunnery flights in India were numbered 1571/1573, of which 1572 Flight at St. Thomas Mount (Madras) eventually became No. 21 Armament Practice Camp. Nos. 1575 and 1576 were both Special Duties Flights. No. 1575 S.D. Flight formed in the summer of 1943 from a detachment of 138 Sqn. at Blida under the command of F/L. J. Austin, D.F.C. and Bar. Its purpose was to open up resistance in Corsica, equipment being mainly Halifax B.2 Series 1 and B.5 Series 1, but Venturas were also flown. A rapid increase in this unit's work soon resulted in its redesignation as 624 Sqn. In India, its opposite number, 1576 S.D. Flight, was formed around the same period with four or five Hudsons at Chaklala. Commanded by F/L. J. King, it divided its time between dropping agents deep in Burma and helping to train supply-droppers at Chaklala. It was eventually redesignated 357 Sqn.

No. 1577 Airborne Experimental Flight served at Mauripur, Dhamial, and Chaklala and in Southern India. Two calibration Flights were numbered 1580 and 1583. No. 1580 formed at Yelahanka, moving to Cholavarum on September 1, whilst the latter was based successively at Akyab, Sambre (from August 1945), and Trichinopoly. Yet another S.D. Flight, No. 1586, was manned exclusively by Polish personnel. Operating with 334 Wing, it flew from Derna, and afterwards Brindisi, flying Liberators, and later Halifax C.8's, coded "GR." At one period it absorbed 301 (Polish) Sqn, and when that unit eventually returned to full strength in England, 1586 operated as a detached flight of it, remaining in Italy. No. 1587 A.O.P. Refresher Flight was attached to the Army at Deolali, whilst 1588 Heavy Freight Flight flew Stirling C.5 transports (carrying Transport Command code "ORT") from Santa Cruz (Bombay) and in Malaya.

Special-duty Units

Simultaneously, the 1600 series was in use, largely for specific-duty blocks. In November 1942, a re-organization of anti-aircraft training units resulted in the disbandment of the various flights of No. 1 Anti-Aircraft Co-operation Unit and their replacement by independent flights. These flights of No. 1 A.A.C.U. had been formed early in the war and were designated "A" Flight, "B" Flight, etc., extending to "X" Flight. Basic equipment was the Hawker Henley T.T.3, but other types in use included the Defiant, Queen Bee, Battle, Magister, Tiger Moth, Lysander and Blenheim. The new flights were numbered from around 1600 onwards, and were designated target-towing flights. Typical of them were 1611 and 1612 T.T. Flights. These started life as "K" and "M" Flights respectively of No. 1 A.A.C.U., the former originating at Weston Zoyland early in the war. It soon moved to Bircham Newton, where it was joined by the newly formed "M" Flight. In December 1941 both flights moved to Langham. Markings were various, but for a lengthy period the Henleys and Defiants, in common with aircraft of the other flights of No. 1 A.A.C.U., carried markings denoting their unit identity, "K" Flight aircraft being coded "K1," and those of "M" Flight "M1."

Soon the flights moved back to Bircham Newton, and Oxfords and Hurricanes were added to their equipment. A few months later, a further re-organization took place; the T.T. Flights were disbanded and their places taken by A.A.C. squadrons. Under this change, 1611 and 1612 T.T. Flight were amalgamated to become 695 (A.A.C.) Sqn. Owing to the extremely short period of their existence, details of the numbers of these flights are obscure, but the following flights of No. 1 A.A.C.U. probably became 1600 series T.T. flights:—"A" Flight (Weston Zoyland and Cleave), "B" Flight (Carew Cheriton and Bodorgan) became 1606 T.T. Flight, "E" Flight (West Freugh), "F" Flight (Squires Gate and Cark), "H" Flight (Ipswich and Martlesham Heath), "J" Flight (Twinwood Farm), "L" Flight (Aberporth), "N" Flight (West Hartlepool), "R" Flight (Cark; used code "T7" on its Martinets after becoming a T.T. Flight), "T" Flight (Towyn and Weybourne), "X" Flight (Weybourne and Watchet), and other flights stationed at Greetham, Manorbier, Merston and Turnhouse.

No. 1641 Flight existed in the United Kingdom at the end of the war, aircraft being coded "MW" and No. 1677 T.T. Flight, based at Netheravon, flew Martinets and used code "HM." No. 1678 Heavy Conversion Flight was formed at Foulsham in September 1943, using Lancaster 2s coded "SW," and was attached to 514 Sqn. On November 23, 1943, it moved to Waterbeach, where it became "A" Flight of 514 Sqn. in the following April. No. 1680 Flight was formed at Colerne for transport duties, using Harrows coded "BJ." It was later redesignated 271 Sqn., and the number re-allocated to 1680 Comm. Flight.

* *Part 1 appeared in "Flight" of February 15.*

BELOW SQUADRON STATUS . . .

This unit operated from Prestwick, ferrying V.I.P.s to the Hebrides, Orkneys and Shetlands. Basic equipment was the de Havilland Dominie, later supplemented by Dakotas.

The next batch of numbers was allocated to Bomber (Defence) Training Flights. These units were employed on fighter affiliation duties, usually in conjunction with a conversion unit or operational training unit, and flew various types of fighters including Tomahawks, Hurricanes, Spitfires and Beaufighters. No. 1681 B.(D.)T. Flight was stationed at Pershore, Honeybourne, Long Marston, and Kinloss; 1682 Flight at Moreton-in-the-Marsh and Enstone; 1683 Flight at Market Harborough; 1684 Flight at Wing; 1685 Flight at Ossington; 1686 Flight at Hixon and Bourne (with No. 8 Group); and 1687 Flight at Hemswell and Ingham, with No. 1 Group (aircraft coded "4E"). No. 1688 B.(D.)T. Flight flew successively from Newmarket, Feltwell, and Wyton, in No. 3 Group. Its aircraft, coded "6H," included Spitfire 5Bs and 5Cs, Martinets, Hurricane 2Cs, and a Tiger Moth. No. 1689 B.(D.)T. Flight flew uncoded Hurricane 2Cs from Holme-on-Spalding-Moor in No. 4 Group, whilst 1690 Flight used Scampton, Metheringham, and Swinderby, in No. 5 Group. In No. 100 Group, 1692 B.(D.)T. Flight flew Beaufighter NF.1s, 2s and 6s from Drem, and later Little Snoring. The remaining B.(D.)T. Flights were 1693 at Sumburgh, 1694 at Great Massingham, 1695 at Dalton and 1696 at Gransden Lodge. At the end of the war No. 1689 was re-allocated to an offshoot of 20 M.U. at Aston Down. This unit, No. 1689 Ferry Pool Pilot Training Flight, employed a variety of aircraft, all carrying code "9X." These included the Wellington T.10; Proctor C.2 and 3; Harvard T.2B; Argus C.2; Anson C.10, C.12 and C.19; Oxford C.2; Spitfire L.F.16E; Lancaster B.7/FE and Mosquito T.3. In May 1944, No. 1697 Air Delivery Letter Service Flight was formed at Northolt. As the Second Front got under way, it operated, as its title suggests, an air-delivery letter service between London and various European capitals. Aircraft, coded "U7," were Hurricane 2s and later Anson 1s. The unit was later renamed the A.D.L.S. Squadron.

Progress Blocked

Thus, with No. 1699 allocated to a (B.S.) C.U. at Oulton, this series ended. Unfortunately, further progress in this direction was blocked, as Nos. 1700 to 1899 had been reserved for new squadrons in the now greatly expanded Fleet Air Arm. Resort therefore had to be made to an earlier block which had not yet been allocated—1300/1399. This new series began with yet another set of Met. Flights, this time in India. Numbered 1300/1303, they included one at Nagpur (No. 1301), and one at Yelahanka (No. 1302). The second flight moved later to St. Thomas Mount. In the United Kingdom, No. 1315 Flight was employed on Transport duties at Merryfield, flying Dakotas. No. 1316 Flight used code "WK." No. 1318 (Comm.) Flight was based at Nassau, in the Bahamas, and No. 1320 Flight, with Typhoons, formed part of the Air Spotting Pool for 2nd T.A.F. during the Normandy landings. No. 1323 Flight used code letters "QF."

In India appeared two more special-duties flights—Nos. 1340 and 1341. The former, using the Harvard T.2 and T.2B and the Vengeance, was formed at Sulur, moving to Cannonore on October 11, 1945, where it disbanded on March 31, 1946; No. 1341 formed at Andby, moving to Digri, Raipur (September 1945), and finally to Singapore. No. 1344 Special Signals Flight, with Hurricane 2Cs, formed at Gujrat, moving to Sambre before disbanding.

There followed a batch of air-sea rescue flights, also in India. Nos. 1347, 1348 and 1349 A.S.R. Flights formed at Agartala from the disbandment of 292 (A.S.R.) Sqn., which had used Warwicks and Liberators. Of these, 1349 Flight survived until 1946, when it disbanded at Mauripur, having moved there with its Liberators in the previous October. Nos. 1350 and 1352 A.S.R. Flights also flew in India, the latter being at Mingaladon, in Burma, before moving to St. Thomas Mount in August 1945. In the United Kingdom, the series finally came to a close, amongst the last units being 1353 Flight (code "YE"), and 1359 (Transport) Flight, this being the Transport Command V.I.P. Flight at Bassingbourne (code "ZW").

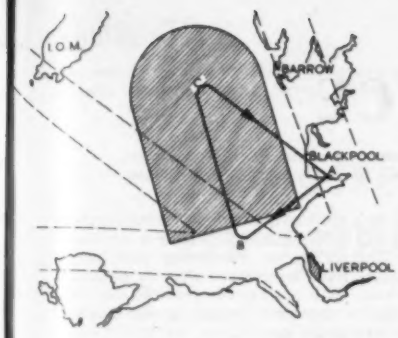
In the post-war period, most of the wartime flights gradually disappeared, but from time to time new ones arose. The most notable development, however, was the commencement of a new series, 1900 onwards, for A.O.P. flights, consequent on a re-organization of A.O.P. units on a peace-time basis. In this country, 657 Sqn. at Andover was re-organized into two flights, Nos. 1900 and 1901. No. 1900 Flight was formed from the former "A" and "B" Flights of 657 Sqn., using Auster A.O.P.5s and later A.O.P.6s, whilst 1901 Flight used a number of Hoverflies in addition. No. 657 Sqn moved to Middle Wallop in 1948, 1900 Flight being affiliated to the 3rd Infantry Division in 1950. In 1951 this flight left 657 Sqn. and was posted to the Middle East as 1900 Independent A.O.P. Flight. In March 1953 it was again posted, this time to the Far East, arriving at Hong Kong the following month and being stationed at Shatin, under the command of the 40th Infantry Division. In July 1948, 656 Sqn. re-formed at Sembawang with four Flights, Nos. 1902, 1903, 1907 and 1914, all with Auster A.O.P.6s. Of these, 1903 Flight moved to Hong Kong in April 1949, transferring to Japan three months later, and afterwards taking part in the Korean campaign as an independent A.O.P. flight. On leaving the squadron it was replaced by 1911 Light Liaison Flight, the latter operating in support of No. 48 Gurkha Infantry Brigade in Pahang (Malaya) at a later period. No. 1903 Flight returned to the squadron in 1953, as a light liaison flight. No. 1907 Flight also operated with the Gurkhas in Malaya, supporting the 26th Gurkha Infantry Brigade, whilst 1914 Flight operated from an airstrip at Benta in Pahang Province. No. 1910 A.O.P. Flight operated in North Africa, being based at Tripoli, and moving in 1950 to Asmara (Eritrea). Success with the Hoverfly experiments of 1901 Flight led to the more widspread use of helicopters, and in October 1951 the first Sycamore flight was formed at Middle Wallop, being designated 1906 A.O.P. Flight. Shortly before this, another light liaison flight, No. 1913, had formed at Middle Wallop under the auspices of 657 Sqn., for operation overseas. It worked up in North Wales, and then embarked for Korea, arriving at Iwakuni (Japan) on October 2, 1951, and later taking part in the Korean war.

Other A.O.P. flights have included 1912 L.L. Flight in Germany, and Auxiliary flights in this country now being disbanded. The latter were formed in 1949, grouped into five squadrons. 661 Sqn., with H.Q. at Kenley, and also using Henlow (later Hornchurch) and Hendon, included 1957, 1958, 1959, 1960 and 1961 Flights; 662 with H.Q. at Colerne and one flight at Middle Wallop comprised 1956, 1962 and 1963 Flights; 663 Sqn. at Hooton Park, with flights at Llandow (later St. Athan), Ringway and Ternhill (later Castle Bromwich), comprised 1951, 1952, 1953, 1954 and 1955 Flights; 664 Sqn. at Hucknall, with flights at Yeadon (later Rufforth), Desford (later Wymeswold) and Ouston, comprised 1964, 1965, 1969 and 1970 Flights; and 666 Sqn. at Scone, with flights at Turnhouse and Dyce (later Abbotsinch), comprised 1966, 1967 and 1968 Flights. All used A.O.P.5s and A.O.P.6s, but later equipment has included Tiger Moths, Chipmunks, and Auster T.7s. At one time Reserve Command code markings were carried, 661 Sqn. using code "ROA," 662 Sqn. "ROB," 663 Sqn. "ROC," 664 Sqn. "ROD," 666 Sqn. "ROG." These markings were dropped, but recently Fighter Command-type markings have appeared, using variations on the theme of a zig-zag in a rectangle, the colours including red, blue and white.

In the original series, flights formed since the war include 1301 Met. Flight, which reformed at Negombo (Ceylon), in June 1949 with Brigand Met. 3s, and 1312 (Transport Support) Flight, publicized last year as being at Abingdon, and flying Hastings. In accordance with present practice, aircraft of the latter unit now carry a red and blue diamond on the fin, with the unit number. No. 1340 Flight re-formed at Eastleigh (Nairobi) in March 1953 for action against the Mau-Mau. It proved very successful, flying twelve Harvard T.2Bs converted to carry bombs. At Bahrein, 1417 Flight operated Ansons, replacing these in 1955 with Hunting Percival Pembrokes; and at Khormaksar, Aden, 1426 Flight is, at the time of writing, operating Lincolns under the command of S/L. D. Smyth.

ALLOCATIONS OF FLIGHT NUMBERS: A SUMMARY

Block	First used	Used by	Allocation	Remarks
1- 200	1912	R.F.C.	Normal sqn. series.	Later taken over by R.A.F.
201- 299	1918	R.A.F.	Ex-naval sqns.	Later merged into normal series.
300- 352	1940	R.A.F.	Allied sqns. of R.A.F.	
353- 399	1942	R.A.F.	Certain sqns. formed in India.	Only progressed to 358.
401- 499	1923	R.A.F.	Naval and coastal flights.	Replaced by sqns.
401- 499	1940	R.A.F.	Normal flight series.	Later all redesignated in 1400 series.
400- 499	1941	R.A.F.	Dominion sqns. of R.A.F.	
500- 509	1925	R.A.F.	Special Reserve (now Aux.) sqns.	Only allotted to 504.
510- 599	1942	R.A.F.	Normal service sqns.	
600- 620	1925	R.A.F.	Auxiliary sqns.	Only allotted to 616.
617- 699	1943	R.A.F.	Normal sqn. series.	
701- 720	1937	F.A.A.	Catapult flights.	Later became sqns.
700- 799	1939	F.A.A.	Catapult sqns. and shore-based non-op. sqns.	
800- 899	1933	F.A.A.	Operational sqns.	
900- 999	1938	R.A.F.	Balloon sqns.	
1000-1299	—	—	—	Not used.
1300-1400	1944	R.A.F.	Normal flight series.	Followed 1600 series.
1401-1500	1941	R.A.F.	Normal flight series.	Replaced 400 series.
1501-1699	1942	R.A.F.	Normal flight series.	Followed 1400 series.
1700-1799	1944	F.A.A.	Shore-based non-op. sqns.	Followed 700 series.
1800-1899	1943	F.A.A.	Operational sqns.	Followed 800 series.
1900-1999	1946	R.A.F.	A.O.P. flights.	Manned by Army personnel.



An English Electric P.TA and (left) on under-30,000ft flight plan from Warton Aerodrome (A). Supersonic speed within the leg B-C can be held for only about 60 sec—too short a time for readings to be taken at more than a single simple test-point. Shaded is the area liable to receive "bangs"; dotted lines indicate airways.

SUPERSONIC TEST RANGES

Would they Solve the "Bangs" Problem?

A NEWSPAPER headline, a year or two old, amongst a wall-collection of such cuttings kept by a member of *Flight*'s staff reads: PUBLIC COMPLAIN ABOUT JET MEN. Now it has been joined by JET MEN COMPLAIN ABOUT THE PUBLIC. The newcomer headed a report that the chief engineers and test pilots of the two companies in Britain flying fully supersonic aircraft have cried "Halt!" to the growing restrictions on their work. For years there has been official sympathy for those people who have had their greenhouses broken, ceilings cracked and animals upset. Now [writes a special correspondent] has come the counterblast.

Mr. R. L. Lickley and Mr. Peter Twiss of Faireys report that after every supersonic flight in the F.D.2 there are widespread complaints. Mr. F. W. Page, of English Electric's Aircraft Division, says that restrictions "hamper" testing of the P.1; that any further restrictions would be "quite intolerable," and that already the restrictions pilots had to observe were "an unfair burden to place on someone engaged on a job which is difficult and hazardous enough anyway."

Present rules prohibit supersonics over land at less than 30,000ft, and supersonic diving over land at any height. Much test flying on supersonic aircraft must therefore be done over the sea. Paradoxically, another Ministry of Supply rule says that valuable prototypes must not be flown over the sea. Despite this the P.1s have done at least 400 flights, probably much more, and the F.D.2s 250! It seems that the rules may have been broken.

Now the Ministry of Supply is seeking to reshape the rules; the minimum supersonic altitude may be reduced to 20,000ft, which may mean that the "bangs" generated will have been worn down to "rumbles" when they reach the ground, and an overland supersonic range may be established for the essential testing which has to be done under 20,000ft. This would mean that pilots could carry out their tests knowing that they were under constant radar supervision and, in low-level sorties and good weather, under visual watch as well. If anything went wrong and they baled out or crash-landed, help would be on its way immediately and it would be directed to the right place. Designers, too, would rather retrieve the bits and pieces of aircraft than resort to the hit-and-miss method of surmising the cause of an accident while the essential evidence lay hidden on the seabed.

The range would have to be great enough for bangs which travel on after an aircraft decelerates to less than Mach 1 to peter out within its confines. Flat, open country would be ideal, but Britain has few such places. Areas which may be considered could be from Wellesbourne Mountford Aerodrome, Warwickshire, due east for about 150 miles to the East Coast near Orfordness. This would be a long, narrow range just missing Northampton, Bedford, Cambridge and Ipswich (but not protecting them from some substantial bangs) and would be particularly useful for the F.D.2 and probably some future aircraft based at Thurleigh, near Bedford. Another choice is over the Welsh mountains, running from the South Wales coast about Llanelly north-north-east to Mold, Flintshire, about 100 miles away. Another range could be over the Pennines north of the Midlands, from Leeds north-north-west to the Cheviot Hills on the Scottish border. These areas would all need to be about 20 miles wide; and very accurate navigation, never simple at high speed, would be needed to keep the aircraft running along the centre line. The ranges over the hills would involve some difficulties with uninterrupted radar surveillance of low-level flights.

"Flight" photograph

If public feeling forestalls an overland range in this country, the Government will be obliged to look elsewhere, for such a range will be an essential part of the long-term plan for developing aviation in Britain. As related by Peter Twiss [p. 267 of this issue] Cazaux, near Bordeaux, was successfully used by Faireys for 52 sorties. But even the comparatively simple F.D.2 felt the embarrassment of being away from its base. And it may be asumed that the novelty of fast aircraft flying over their homes will wear thin as quickly with the French (to whom it may not be such a novelty by now, anyway) as it has with ourselves. The North African desert would be ideal. So would Woomera. But companies using Continental sites (and they will increase in number as time goes on) would need to move their maintenance bases out there, and have a frequent and costly air service carrying personnel and spares between the ranges and their developmnt centres. The organizational disadvantages and the subsequent dislocation of test programmes make these far-away places very doubtful sites—at least for some years.

An interim measure could be more and larger over-sea ranges. One over Cardigan Bay, where flying could be dovetailed in between missile firings from Aberporth, would be useful for English Electric, who have already used the area for gun-firing trials at supersonic speeds. Another along the South Coast from Selsey Bill to Beachy Head would be clear of main shipping lanes and fairly close to the A. and A.E.E., Boscombe Down, which will soon be receiving supersonic aircraft.

The minimum requirements for an over-sea range would be (a) enough helicopters to have at least two airborne, not just standing by, during each test flight; (b) Sarah equipment for all pilots; and, of course, (c) constant radar cover. This last item will be a considerable expense at either sea or land ranges, for the most modern equipment is needed to keep track of supersonic aircraft. Ordinary airfield surveillance radar is not sufficient, because of the time between "paints" and its inability to get sufficient response from the small volume of echoes from a small-frontal-area aircraft when seen nose-on or tail-on. Such shortcomings would deprive the plotters of an accurate picture of the flight path at a reasonable range.

All these suggested ranges—and, no doubt, most others which may be suggested—will clash in some measure with the present civil airways. Obviously these must be respected, but they will be an added embarrassment to supersonic flying, particularly when the maximum height of the traffic lanes is raised to 25,000ft for turboprop aircraft, and (later) probably higher still for turbojets. It will be necessary to move the lanes away from the areas designated as supersonic ranges.

Whichever ranges are chosen—the aircraft industry will demand that one or more are chosen and the Government cannot do other than support the demand—many more bangs will in future echo across the British countryside and coastline. As more P.1s come along, and the Blackburn N.A.39 appears (and perhaps other aircraft with higher Mach numbers and capable of sustaining them for long periods), the ranges will be in use day and night. Only the new and unproved aircraft will use the ranges; supersonic aircraft in normal service will, as Peter Twiss said in his lecture, fly patterns which will give the minimum disturbance to the public. Establishing a range will not be a simple matter of passing legislation almost unnoticed. It will be a long political wrangle, reaching from Parliament down to the public bars of the villages lying within the areas ultimately selected.

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns; the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

The Shuttleworth Trust's 504

(From A. Cdre. A. H. Wheeler, C.B.E., Trustee (Aviation), The Shuttleworth Collection.)

THOSE interested in veteran aeroplanes will be glad to know that the Shuttleworth Trust's Avro 504K, which sustained minor damage last summer in a forced landing in standing corn, will be fully serviceable again this season. The most difficult part of the repair was to the propeller, other damage being superficial. However, as the result of a most generous gesture by the Airscrew Company and Jicwood, Ltd., and help from the proprietors of *Flight*, for which the Shuttleworth Trust are most grateful, a new propeller is being made.

At present a "light" propeller is fitted, which gives the 504 an exceptional take-off performance but would bring the risk of serious over-revving in the air.

Old Warden Aerodrome, Biggleswade, Beds. ALLEN WHEELER.

Refugees from Hitler

I MUCH enjoyed Part 1 of the article "Ensign Class" in your publication of February 15. During the early days of the war I was an air-traffic control officer at Shoreham and can confirm that the Fw200 Condor G-AGAY originally belonged to D.D.L., with the registration OY-DAM. This aircraft, or its sister ship OY-DEM, used to spend every second night at Shoreham, arriving there from Copenhagen and Amsterdam one day and returning to Copenhagen the next.

OY-DAM was at Shoreham when the Germans invaded Denmark and was seized as prize. The aircraft was later flown to Whitchurch by the Danish crew with a prize crew on board.

The DC-3 G-AGBI *Wulp*, also mentioned in the article, was originally K.L.M.'s PH-ARW and was another regular caller in those happy and busy Shoreham days.

St. Helier, Jersey. R. T. A. DALTON,
Senior Air Traffic Control Officer, Jersey Airport.

On Not Dropping the Pilot

A COMMENT by the Secretary of State for Air during the recent Defence Debate, that "Air defence must be evolutionary not revolutionary", contrasted sharply with suggestions in the daily Press that Fighter Command is about to be axed in favour of a brigade of missile button-pushers.

Taking the remark literally, it is interesting to speculate, within the limits of security, on how our air defences may evolve in the next ten years. (Even the staunchest protagonists of fighter aircraft expect that after that period pilots will give way to collections of black boxes.)

A few months ago the future pattern of defence against the bomber seemed clear. In the Hunter F.6 and Javelin, the R.A.F. has intercepters good enough to offer a reasonable defence against the Soviet bombers known to the West as "Bison" and "Badger." The P.1B appeared destined to follow them into service, to deal with fully-developed versions of these jet-bombers.

Beyond, to cope with the first supersonic bombers, was seen the mixed-power-unit intercepter—notably the Saunders-Roe S.R.53, now approaching its first flight at Boscombe Down, but with reports from America that the P.1 also will have a rocket pack under its fuselage in due course. This would be logical, because the added performance at height would be invaluable. Furthermore, a suitable rocket-motor is available in the shape of the Napier Scorpion made by another member of the English Electric group, and its use would explain a reported comment by the C-in-C. of Fighter Command that the P.1 will be capable eventually of 1,500 m.p.h.

A production order has been placed for the P.1B; so we can assume that its future is assured: but what of the S.R.53? Will revolution overtake it, or is it evolutionary enough to offer the best possible means of defence against the bomber between, say, 1960 and 1967? All that we know about it officially is that it is an intercepter powered by a rocket motor and a turbojet. U.S. reports say that these are respectively a de Havilland Spectre and an Armstrong Siddeley Viper, with the latter scheduled to be replaced by a Gyron or Gyron Junior in the production version.

If these assertions are accurate, the S.R.53 would have to be fairly small, or the Viper would not get it off the ground. Nor are its designers likely to have overlooked the fact that some NATO countries, particularly Germany, are interested only in aircraft that will take off from short grass airfields to defend them after the current crop of intercepters becomes obsolescent.

So, although we know nothing of the shape of the S.R.53, it seems probable that it will be a nimble, lightweight aircraft rather in the class of the French S.O.9050 Trident 2, which is similarly jet-and-rocket-powered. This raises an interesting possibility, because the Trident's makers have announced that its ultimate development will be pilotless. Is it not equally feasible that the S.R.53 could be evolved into an unmanned missile in due course? Such evolution would not only make good sense, but might even be inevitable. For example, it was largely because of the occasional erratic behaviour of pilotless targets that aircraft like the unmanned Firefly U.8 and U.9 and Meteor U.15 and U.16 had to be produced as targets for missiles at Aberporth and Woomera. As they have a cockpit with normal controls, a check pilot can fly them to a safe height, then sit back and fold his arms while the machines are tested under remote control, so offering reasonable certainty that they will not cause abortive missile-launchings in subsequent pilotless flight.

Similarly, there is little doubt that Boeing have discovered that the cheapest and best way of perfecting their Bomarc intercepter is not by repeated trial and error launchings but by letting a pilot go along with the guidance system to keep an eye on its functioning. This accounts for the appearance of a Temco-modified B-57 with 17ft of simulated Bomarc on its nose, two or three years after the first firing of this missile.

This B-57 is a device to get the Bomarc guidance system up to the altitudes where Boeing want to put it through its paces. The next generation of piloted intercepters, such as the S.R.53 series, will be devices to put air-to-air guided missiles in the right position to ensure destruction of enemy bombers. In short, they will be "boosters" for a homing warhead, performing the same function as the rocket-motors of a ground-to-air missile, but with a pilot to make sure that the warhead goes in the right direction, until such time as a black box can be made to do the job as efficiently.

To picture a pilot as an interim black box and a sleek supersonic intercepter as little more than a booster may remove some of the "knights in shining armour" glamour of the fighter squadrons; but the degree of ground control and automatic fire control already used with aircraft like the Convair F-102 is not very far from this concept. In any case, there is nothing glamorous about atomic warfare and the most suicidal mistake that anyone could make would be to drop the pilot prematurely.

Perhaps in following a simple line of thought that was inspired by a few words in a lengthy debate I have added two and two together and made twenty-two. But if the S.R.53 could begin by giving us the finest possible defence in the last few years of piloted interception and then, like the Trident, go through one more stage of evolution into a proven, perfected pilotless missile, it might be a good deal better economically than a protracted programme of trial and error with undeveloped missiles of orthodox concept.

Surbiton, Surrey. JOHN W. R. TAYLOR.

FORTHCOMING EVENTS

Mar. 2. British Interplanetary Society: "Design and Application of Solid Propellant Rocket Motors," by E. T. B. Smith, B.Sc., A.F.R.Ae.S., G.I.Mech.E.
Mar. 5. Aviation Forum: "Air Traffic Control," by E. G. Fitch.
Mar. 5. R.Ae.S.: Graduates and Students Section: A.G.M. and Film Show.
Mar. 7. R.Ae.S.: Tenth Louis Blériot Lecture: "New Methods in Aircraft Production," by M. Badré, production director of Ouest Aviation.
Mar. 8. Helicopter Association: "All Weather Operation of Helicopters—Engineering and Piloting Aspects," by P. A. Hearne, D.C.Ae., and J. W. Read, D.F.C.
Mar. 12. R.Ae.S.: Section Lecture: "High Temperature Materials for Engines," by E. R. Gadd.
Mar. 13. Royal Society of Arts: "The Air Training Corps," by W/C. Norman Macmillan, O.B.E., M.C., A.F.C., D.L., A.F.R.Ae.S.
Mar. 15. Institute of Transport: Annual Dinner, Dorchester Hotel.

R.Ae.S. Branch Fixtures (to Mar. 15)

Mar. 4, *Derby*, "Problems of Rocket Development and Supersonic Flight," by A. V. Cleaver; *Henlow*, "Bird Flight," by Dr. R. H. J. Brown. Mar. 5, *Boscombe Down*, Film and/or Medal Lecture Evening. Mar. 6, *Chester*, "A Century of Aeronautical Research, 1804-1903," by J. Laurence Pritchard; *Gloucester*, "Flying Boats," by H. Knowler; *Luton*, "Advantages and Disadvantages of Swept Wings," by D. Küchemann. Mar. 7, *Belfast*, "Viscount Operation," by E. R. Major. Mar. 13, *Bristol*, Fourth Barnwell Memorial Lecture, "Education in Industry," by Prof. A. R. Collar; *Manchester*, Second Chadwick Memorial Lecture, "Influence on Aircraft of Aeronautical Research," by M. B. Morgan; *Southampton*, "Production Development," by L. G. Burnard; *Weybridge*, "Problems of Jet Transport Operation," by J. T. Dyment. Mar. 14, *Isle of Wight*, "Fleet Air Arm Tactics and Strategy," by Capt. D. R. F. Cambell; *London Airport*, "Problems of Jet Transport Operation," by J. T. Dyment. Mar. 15, *Birmingham*, "Medical Aspects of High-Speed Flying," by G/C. W. K. Stewart.

A heater element for the de-icing equipment described below is shaped on a former of the blade contour.

Propeller De-icing

Electro-thermal Mats for Viscounts

DEPOSITION of ice starts when moist air is cooled to a temperature below the freezing point of water. Air is able to retain some of its moisture at temperatures as low as −20 deg C, but the conditions most conducive to the icing-up of aircraft occur at about −6 deg C, when a large proportion of the moisture content of the surrounding air will freeze on any convenient surface. Since modern aircraft fly at heights at which the temperature of the air is normally below 0 deg C, even in summer, the problem of de-icing is a pressing one.

Although all parts of an aircraft are subject to icing, difficulties are particularly acute in the case of the propeller. Under conditions favourable to "impact" icing, the high propeller blade velocity—which can exceed the speed of sound at the tips—leads to a rapid build-up of ice on any unprotected part of the leading edge. Such a build-up is undesirable for aerodynamic reasons in any location; but, on the propeller, its weight has the peculiar disadvantage of tending to unbalance the rotating parts. A half-pound slab of ice at a radius of 3ft, for instance, would set up an unbalance force of some 730 lb at a rotational speed of 1,200 r.p.m.

Although electric de-icing has proved widely successful in service, great care is needed in applying this system to propellers. In particular, the high velocity of the air meeting the blade necessitates a relatively high electrical unit loading.

Consumption is, however, reduced by the employment of so-called cyclic de-icing. This system permits a short unheated period in which the ice is allowed to build up to a thin film on the leading edge of the blade. Before this film achieves a thickness sufficient to interfere appreciably with the aerodynamic characteristics of the blade, the cyclic control applies heat. The thin layer of ice already deposited then acts as a form of thermal lagging, so that only that ice in contact with the blade surface melts. Provided this melting is even, centrifugal force throws the entire loosened sheath of ice clear of the blade. The importance of uniform heating cannot be overstressed, since patchy melting would result in the ice being cast off in small pieces with a consequent disturbance both of balance and of aerodynamic performance.

An obvious advantage of cyclic de-icing is the great reduction in energy needed to keep the blades free from serious build-up; a reduction which can be as much as 90 per cent of the energy needed to melt all the ice deposited. Quite apart from the wastage of energy, experience has indicated the functional undesirability of heating propellers continuously to eliminate the formation of ice—"anti-icing," as it is usually termed. With continuous heating, the airstream drives the water formed from the melting ice towards the trailing edge of the blade, where it rapidly refreezes unless additional heating is provided over the entire blade.

Following extensive testing, both in flight and in their laboratory, Rotol, Ltd., Cheltenham Road, Gloucester, have decided that an electric heating element incorporating a resistance wire forms the most successful basis for the effective de-icing of propellers. Such heaters are now used as the basis for the electrical overshoe which forms an integral part of the de-icing system developed by Rotol for their propellers on the Vickers Viscount. Although originally developed by Rotol engineers, the special heaters are now obtained from several outside sources specializing in this type of equipment. A typical heater (made by Isopad, Ltd., Barnet By-Pass, Boreham Wood, Herts) is shown overleaf, the dark resistance wire being clearly seen against the white glass fibre yarn with which it is interwoven.

Generally similar heaters, with either a glass fibre or a quartz weave, are being increasingly used for a wide variety of surface-heating applications in the electrical, chemical, petroleum and other industries, where temperatures of up to 800 deg C are required, since these heaters have the pliability necessary to mould themselves closely to the contour of the component being heated.

An important detail in the winding, however, distinguishes de-icing units from standard industrial surface heaters. In the standard type of heater employed in the earlier experiments on de-icing, the resistance wire ran parallel to the leading edge of the blade. It was found that, in operation, the flexing of the blade imposed such stresses on the wires that they were liable to fracture. The design was therefore altered in such a way that the wire now zig-zags outwards from the root of the blade. The heater is thus capable of responding to movements of the blade without itself being subject to any appreciable stress.

Since it is essential for electrical resistance to be constant along the whole length of the element, uniformity is ensured by close attention to the weaving process. The warp threads are of 0.010in glass-fibre yarn, while the wire element forms part of the weft.

The wire used must conform closely to a detailed specification laid down by Rotol engineers as a result of extensive tests. Both dimensional accuracy and composition are held within close limits; and to impart the necessary taper to enable the heater to fit the blade, the legs of the zig-zag pattern must become progressively shorter. Their length is also subject to rigorous checking.

One of the difficulties encountered in development was the avoidance of a rigid connection to the flexible heating element, since this would result in a point of weakness which might cause trouble in service. This problem was overcome by extending certain wires in the elements to form connecting leads and shunting them with a low-resistance flexible conductor. By tapping the two circuits, a balanced three-phase parallel star network is obtained. The heater is connected to the slip-ring assembly in the hub, which supplies power at 400 c.p.s. from the 208 V alternator mounted on the engine-driven Rotol gearbox.

Apart from tests carried out by the makers immediately after weaving, each heater element is carefully inspected at the Rotol works. In addition to electrical tests, the weave is closely studied by transmitted light. This method of visual inspection clearly shows the path of the opaque wire among the translucent glass fibres. If there are any kinks in the wire, or if the zig-zag pattern is not regularly spaced, the entire unit is at once scrapped.

After stringent acceptance tests, the heaters are passed to the overshoe assembly line, where they are assembled by a vulcanizing process into a de-icing overshoe. In the later versions, Monel gauze is fitted over the heater and insulated from it. (Illustrated above is a stage in the assembly of the overshoe.)

The Neoprene layer forming the outer skin is of special composition (also specified by Rotol engineers) to withstand abrasion by sand, dust and hail, as well as changes in temperature, pressure and humidity to which the propeller will be subject in service. The object of including the Monel gauze is to protect the heater against sharp stones and grit which can be sucked up by the blades from runways.

The moulding former has a rebate equivalent in depth to the thickness of the overshoe. The blade is similarly rebated so that when the overshoe is fitted on it, its contour is restored to the correct aerodynamic shape. The overshoe is made over-size, the surplus being trimmed off and ground flush after fitting to the blade. This overshoe assembly is cured in an autoclave, using the evacuated-rubber-bag technique, under carefully controlled conditions. After removal from the mould, but before being fitted to the blade, the overshoe is subjected to further tests, including X-ray inspection, electrical checks and determination of the true moment-balance figure. [*Contd. overleaf*

A heater under inspection, showing the zig-zag pattern of the resistance wires in the glass-fibre yarn.

PROPELLER DE-ICING . . .

The overshoe is then mounted on a blade and the adhesive cured under pressure. The surplus rubber is trimmed off, after which each blade is put through a rigorous test programme. A heat run is carried out, during which the power input is slowly increased to a value giving a specified surface temperature, which is maintained for some time. During this test the heaters are closely scrutinized for hot spots and air bubbles which may be trapped between overshoe and blade, or within the overshoe. Following this, a flash test is carried out at 1.7 kV between the heater and the blade; insulation resistance must exceed 100 megohms. After testing, each blade is carefully moment-balanced to ensure dynamic balance on the finished propeller.

The spinner is also provided with electric de-icing gear. Eighteen separate heaters of trapezoidal shape are cemented radially to the shell of the spinner. They give a power loading of 11 W/sq in, or a total dissipation of 2.7 kW. Current is again supplied from the slip-rings which feed the heating elements on the blades. Spring-loaded plungers allow the shell of the spinner to be removed without disconnecting the wiring to the heaters.

Economy in alternator capacity is achieved by arranging for the spinner and blade heaters to cycle alternately with those on the associated engine (Rolls-Royce Dart) air intake. Normal complete cycle times are between 120 and 360 sec, depending on the severity of the icing conditions encountered. In service, the initiation of de-icing is not performed automatically. Instead, current is switched on by the pilot when ice has reached a predetermined thickness. Cycling is purely automatic from then on, the choice of the fast or slow cycle being determined by the outside air temperature.

Although the use of this type of electric surface heater has been described for de-icing a particular type of aircraft, the range of application is extremely wide. An interesting recent case has been the simulation of high-speed flight, as far as the frictional heating of aircraft skins is concerned. Isopanels of special construction, capable of short-time loads (about 30 seconds) of up to 10 kW per square foot are used.

Similar heaters are also widely used on airfields and test installations, for frost-protection on compressor lines, storage tanks, fuelling equipment and as drum heaters to reduce the viscosity of oils and other materials before use.

On the manufacturing side, electric surface heaters are rapidly replacing other forms of heating for the curing and part-curing of resinated plastics. Their use often eliminates the need for special ovens, so that considerable savings can be achieved. Further developments are likely to take place, since such surface heaters combine the traditional benefits of electricity in the way of efficiency, cleanliness and ease of control with the additional advantages of high unit loading, flexibility, compactness and ease of application.

TALKING ABOUT TITANIUM

(continued from page 270)

Greatly extended use of titanium tube is awaiting the result of a programme of work now in hand on the production of tube with enhanced fatigue resistance. Many components in hydraulic systems can already be made from alloys such as I.C.I. Titanium 314A or 318A and various firms are understood to be doing development work in this connection. Problems associated with the galling of titanium are holding back some uses but there is much hope that various surface treatments (such as oxidation, anodizing, cyaniding, electro-plating or chemical deposition) can help in this direction.

ECONOMIC APPLICATIONS IN AIR TRANSPORT

By Dr. H. W. Shaw, Development Department, I.C.I. Metals Division

In order to develop useful characteristics, titanium has to be prepared to a standard of purity that until recently would have been unique amongst engineering materials. It is therefore pertinent to ask whether the civil aviation industry can afford to incorporate the new material on a purely economic basis. We must confine ourselves to applications in conventional subsonic aircraft and to applications where the substitution of titanium complies fully with design requirements and where the primary advantage is a weight reduction. The latter condition is stipulated to exclude the case for compressor blades.

[Dr. Shaw examined the operating statistics of British European Airways for 1955-6 and showed that the yearly revenue from each pound carried was slightly over £38. A similar calculation for B.O.A.C. showed a figure of around £50, and later jet aircraft on the North Atlantic might establish a figure between £85 to £95. After making all suitable deductions one was left with yearly figures of £17-£22 for B.E.A. and from around £30-£80 for B.O.A.C. and these sums would have to meet the costs of incorporating titanium, together with replacement charges, and yield a suitable profit margin.]

The cost of incorporating titanium in the form of a finished component is a detail on which further information would be welcomed. In the case of the first major applications, namely the substitution for stainless-steel sheet in heat- and fire-resisting zones, a little personal experience with one-off research components made in a development shop with traditional tools suggests an absolute upper limit of £67 per lb of weight saved at Ministry contract prices. In batch production in aircraft quantities with press tools it is felt that the cost of weight saving should not exceed £20 per lb.

In the extended uses visualized in the nearer future (where stressed components might be incorporated both in engines and parts of the aeroplane such as the undercarriage) fatigue and the implications it has on service life before replacement is required becomes a much more important factor. Again the utilizations of the primary material with complicated machining from bar or forging may be so low that the economic "break-even" point cannot be reached. This consideration suggests that extensive developments in the field of fabrication by welding and other means may be expected in the future with the need to conserve expensive material.

SHEDDING LIGHT ON WEIGHT

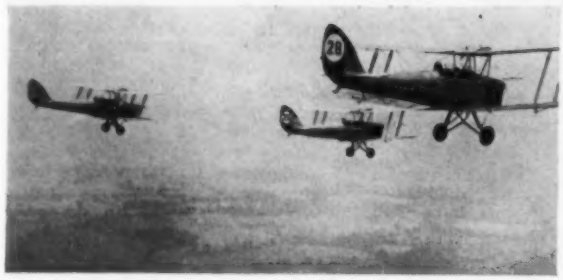
"He that removeth weight doth as much advantage motion as he that addeth wings" wrote John Pym in the seventeenth century; an apposite quotation that was used by the Society of British Aircraft Constructors to preface their third Display of Weight Control held at the Seymour Hall, London, between February 14 and 20.

The attractive layout of the exhibition was obviously the result of considerable hard work and imagination by the Society, who used the term "weight control" to embrace various aspects of design efficiency and so disseminate information on new manufacturing techniques and processes which might be used to further weight-reductions.

The exhibits consisted largely of components and detail parts, all contributed by manufacturers as examples of lightweight design for a specific purpose. In many cases examples of "before and after" weight reducing were shown—the result of a change of material, re-appreciation of the stressing problem after testing, the use of novel techniques or just better design. But regardless of source, each exhibit was cloaked in anonymity, and placarded only with its description and the way in which its weight had been reduced. There was, consequently, a good deal of speculation among many of the visitors as to which firms were responsible for some of the more advanced construction techniques.

Materials much in evidence were resinated glass-fibre, expanded-honeycomb sandwich and titanium, fabricated examples of which were used to show that remarkable weight-savings that are possible by intelligent application. The relative merits of any choice of materials obviously requires to be weighed very carefully; at opposing ends of the hall were examples of a machined component that was lighter—on a strength-for-strength basis—in forged light alloy rather than in cast magnesium-zirconium and another part where magnesium-zirconium had an advantage over light alloy. Nor must methods of attachment (among the host of weight-saving ideas) be forgotten. "Jo-bolts" are a useful lighter alternative to hexagon bolts and nuts in structural applications; and puddle-welding—examples of which were also displayed—can be used to join together light-gauge metal with practically no increase in weight at all.

Project analysis is an important part of the weight estimators' task, and a section of the display was devoted to a *résumé* of the problems with which he is confronted and an analysis of the mechanics of solution. Modern methods of weight control shown in this section included punch-card indexing and the Librascope balance computer into which can be fed payload and structure-weight information; the centre of gravity is then computed.



Members of the Tiger Club (see second item below) practice formation flying between Croydon and Fair Oaks in preparation for their proposed displays this season. Tucking up close in G-AOAA are Messrs. C. Nepean Bishop (C.F.I.) and W. V. Fitzmaurice.

CLUB AND GLIDING NEWS

FROM Belfast and from Hatfield, from Rutherglen and the Isle of Wight, comes news of the hatching of Druine Turbulents and Turbis. The Popular Flying Association reports that the first U.K. Turbulent—being constructed by the Rev. P. O'Kelly of Belfast, assisted by Mr. J. Kirkpatrick of Short Brothers and Harland, Ltd.—has now been registered G-APCM; and that a race is on to see which of the first three Turbis will be flying soonest. One of them—that being built in the Isle of Wight—has now received the appropriate registration G-APFA.

MEMBERS of the Tiger Club are forgathering with their aircraft at Fair Oaks Aero Club next Sunday, March 3, to celebrate the faithful D.H. Tiger Moth's quarter-century of continuous use in civilian and Service flying. This is an informal occasion, anticipating the official celebration at Sywell on May 5, and all owners and pilots of Tiger Moths are invited to attend. The Fair Oaks Club has agreed to provide light refreshments for visiting crews, but because of fuel restrictions cannot perform a similar service for aircraft; and there is to be a prize for the Tiger crew who arrive at dispersal and switch off their engine nearest to a sealed time between 1145 and 1215 on Sunday morning.

THE P.F.A. has finally agreed with the designer on the sale of plans for the C.P.30 Emeraude, a two-seater (side by side) cabin aircraft, and preliminary flight-testing has been carried out by the Association. Price of the plans will be about £30 (with a supplementary charge for a translation from the French) and it is pointed out the machine is suitable for the rather more advanced amateur constructors. A version of the C.P.30 is already being commercially manufactured in the U.K. and should fly this spring.

AS a result of recent talks between representatives of the British Gliding Association (Philip Wills, Ann Welch, Godfrey Lee and Maurice Imray of the R.Ae.C.) and the Ministry of Transport and Civil Aviation, the M.T.C.A. has agreed to revise the northern boundary of the London Terminal Control Area so as to bring Dunstable out into the airway, thus making it possible for London Gliding Club members to fly under all conditions to a maximum height of 3,000ft a.s.l. The Ministry also gave an assurance that they would "make things easy" for the L.G.C. in further revision of control zones; and it was further agreed that permanent gliding sites should be marked on new editions of air maps.

AT Baginton there have been secretarial changes in the Armstrong Siddeley Flying Club. Harry Bennett has for personal reasons had to resign the secretaryship and it has been taken over by Phil Walker, whose former position as assistant secretary is now filled by Dennis McManus. The latter (according to the club's February newsletter) only just missed going solo during January, a distinction achieved by Charles Reeves and Derek Hart; while Frank Hudson and Ron Horsley gained P.P.L.s. The club now has 26 "soloists" and nine P.P.L. holders and during 1956—despite having the Tipsy immobilized six weeks for C. of A. checks—did 220 hours' flying.

A MEMBER of the Yorkshire Aeroplane Club at Sherburn-in-Elmet, E. R. Walters, flies an Aeronca 100 (36 h.p. Aeronca flat twin) which is thought to be the only one still in use in the North of England. A petrol consumption of 2½ gal/hr and a cruising speed of 75 m.p.h. are quoted for G-AEVS, and Mr. Walters hopes to fly it to the Deauville Rally this year. *Flight* readers may recall an article (April 6, 1956), by a previous owner, on a trip to Le Mans in *Veronica*, as G-AEVS is named.

WE regret to record the death of Mr. F. J. Poulter, A.F.C., B.E.M., a member of the technical publication department staff of Vickers-Armstrongs (Aircraft), Ltd., at Hursley Park and in his spare time an instructor at the Supermarine Works Flying Club, where each week he gave lectures on all subjects necessary for pilots under instruction. Prior to joining Vickers in September 1954 he had served in the R.A.F., joining as a boy at Cranwell in 1920, later training as a pilot and retiring in May 1954 with the rank of squadron leader.

THE INDUSTRY

Marconi Staff Posts

TWO new posts in the aeronautical engineering side of Marconi's Wireless Telegraph Co., Ltd., have been created. Mr. G. P. Parker, A.M.I.E.E., has been appointed deputy chief air radio engineer (development), and he will undertake responsibility for the airborne and ground development group of the aeronautical division. Mr. J. H. Gill has been appointed deputy chief air radio engineer (projects), and will be in charge of work on airborne and ground installation projects. Both these specialists will be responsible to Dr. B. J. O'Kane, Ph.D., B.Eng., A.M.I.E.E., chief air radio engineer.

Messrs. G. P. Parker, J. H. Gill and F. S. Mockford.

In addition, the following have been appointed to posts on the engineering sales staff: Mr. B. J. Infield, M.A., technical representative (overseas); Mr. E. Swinney, M.I.E.E., technical representative (home); and Mr. E. Hird, technical representative in the United States.

Also from Marconi comes the news that Mr. F. S. Mockford, commercial manager of Marconi's Wireless Telegraph Company, Ltd., has been elected chairman of the Radio Communication and Electronic Engineering Association (R.C.E.E.A.). His election is for the second time: he was chairman in 1949. From 1915 to 1919 Mr. Mockford served as a lieutenant (wireless) in the R.F.C. and later the Royal Air Force. As the first wireless officer at Biggin Hill fighter station, he installed the very first airborne R/T. equipment to go into service.

In October 1919 he took up a civilian wireless appointment with the Air Ministry, and was stationed at Hounslow and, a little later, at Croydon. Here he was responsible for much of the planning and organization of the communications and D/F. services. He conducted the original examination of candidates for air operators' licences and did the first crude but successful bad-weather "talk-down." Mr. Mockford joined Marconi's in 1930, and was at one period manager of their air division.

THE INDUSTRY . . .

Tiltman Langley Board Appointments

FROM Tiltman Langley, Ltd., comes an announcement of changes in their Board of directors. Mr. L. A. Wingfield, M.C., D.F.C., is appointed chairman; Maj. H. H. Sykes, managing director; Mr. Marcus Langley, F.R.Ae.S., A.M.I.Mech.E., technical director; and Mr. L. D. Neeves, F.C.I., secretary. A new appointment to the Board is that of Mr. N. W. Collett.

Mr. Marcus Langley.

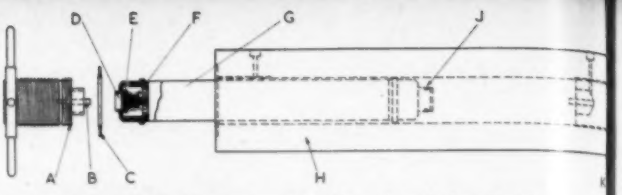
Mr. Marcus Langley, who resigned from the managing directorship last year, is now fully restored to health and heads a new technical department set up to advise on scientific and engineering technology both in this country and abroad and to maintain liaison with ministries, research establishments and aircraft firms.

As is well known in the industry, Tiltman Langley have for many years past provided service in the fields of research, analysis, design and development. Their activities have resulted in the granting of over 40 patents, including such items as flow-control valves, variable-speed gears and a process for soft soldering aluminium and aluminium alloys.

Cartridge-type Dryers

ILLUSTRATED in a diagram above, a new type of air dryer, particularly suitable for drying air before storage in high-pressure bottles, has been developed by the Dryer Division of Birlec, Ltd., of Erdington, Birmingham 24.

In general, where extreme reliability with light weight is essential regardless of cost, desiccant can be supplied from the factory in a sealed cartridge, which, before insertion into a suitable pressure vessel, is opened and subsequently discarded when the desiccant is saturated. Whilst Birlec manufacture sealed cartridges of this type, it was evident to them that there was also a need for a relatively inexpensive dryer, capable of reactivation, handling small volumes of air for a limited time.



Details of the Birlec air dryer described below: A, end plug; B, valve-operating spindle; C, Dowty seal; D, valve housing; E, seating; F, valve; G, removable cartridge; H, pressure vessel; J, O-ring seal; K, plug.

For such duties they accordingly developed a standard cartridge dryer fitted with a spring-loaded poppet valve. Insertion into the dryer vessel or reactivator depresses and opens the poppet valve; conversely, withdrawal enables the poppet valve to close, thereby sealing the desiccant from atmospheric air.

The vessel has a screwed cap designed to facilitate the removal of the cartridge. The reactivator is fitted with a heater and blower to ensure that the moisture evolved by the desiccant during heating is expelled to waste, and not—as can happen—re-adsorbed when the desiccant cools down again.

In the diagram one cartridge is in the process of being inserted into the pressure vessel; it is seen that the inlet and outlet connections do not have to be broken. There are two standard sizes of cartridge at present, the G.2.5 and G.5. Pressure vessels for these measure, respectively, 2ft 7in by 8in square and 4ft 4in by 8in square. Multiple cartridges can, of course, be connected in parallel.

For Production of Semiconductors

WITH the title Texas Instruments, Ltd., a new company to produce a full range of both silicon and germanium semiconductors, including transistors, rectifiers and diodes, has been formed at Bedford. It is a subsidiary of the American concern Texas Instruments, Inc., of Dallas and Houston, Texas, and Monrovia, California; and its managing director is Mr. Dudley Saward, O.B.E. New buildings, to contain both factory and offices in a 12,000 sq ft floor area, are being built in Kempston Road, Bedford.

The American parent company has long specialized in prospecting and making instruments for geophysical research and now claims to be the largest individual producer of semiconductors in America. An affiliated company, G.S.I., Ltd., London, has already been operating in this country for some time.

IN BRIEF

High Duty Alloys, Ltd., Slough, Bucks, have produced an informative illustrated booklet on the advantages of shell moulding as applied to castings in Hiduminium.

* * *

Amplivox, Ltd., have appointed Mr. R. Steven, B.Sc., manager of their industrial division. He was formerly sales manager of Painton and Co., Ltd., Northampton.

* * *

Nearing completion are new premises extending by 30,000 sq ft the factory and office accommodation of Flexello Castors and Wheels, Ltd., Bath Road trading estate, Slough, Bucks.

* * *

A new price-list has been issued by Weather and Co., Ltd., 21 Malden Crescent, Chalk Farm, London, N.W.1, makers of industrial coverings ranging from tarpaulins and ropes to overalls, carpenters' aprons and industrial gloves.

* * *

Auto Diesels, Ltd., have formed a new division for their pump and hydraulic machinery products. Mr. R. J. Sanders has been appointed its general manager and he is succeeded as home sales manager by Mr. Edward Ward.

* * *

Fescol, Ltd., North Road, London, N.7, have published a 28-page reference booklet, for customers and potential customers, on the electro-chemical deposition of metals. With it in a folder are five leaflets, each covering the application of the Fescol process to a specialized field.

* * *

As an addition to their range of small diaphragm compressors the Hymatic Engineering Co., Ltd., Redditch, Worcs, have developed a twin-cylinder unit, type DP.14, which can operate continuously at pressures up to 50 lb/sq in. Among applications cited is the pressurization of radar and electronic equipment.

* * *

Lec Refrigeration, Ltd., Bognor Regis, Sussex, operate a Gemini, and recently it carried out a useful air-lift when the company urgently wanted some Unionmelt powder for their welding installation. A supply was brought by road from Bilston, Staffs, to Elmdon airport, Birmingham; and the aircraft, which had taken off from the company's private airfield at Bognor at 10.50 a.m., arrived back there with the powder shortly after 1 p.m.

Dowty Equipment, Ltd., Cheltenham, Glos, have produced an illustrated brochure describing their latest test rigs and ancillary equipment for the testing and maintenance of hydraulic and fuel systems.

* * *

Recently appointed sales and advertising manager of the Short Brothers and Harland general engineering division—which manufactures the Metoluk range of products—Mr. Arthur J. Eadon, M.S.M.A., joined Shorts in 1948, having from 1939 to 1945 been with Vickers-Armstrongs (Aircraft), Ltd., as technical representative on the production of Wellingtons.

* * *

Early last year it was made known that Air Trainers, Ltd., of Aylesbury, were entering into a closer business relationship with Link Aviation, Ltd., of Binghampton, New York. It is now announced that the name of the British company has been changed to Air Trainers Link, Ltd., and that the Board has been strengthened by the inclusion of representatives of the American organization.

* * *

The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2, has developed a D.C. multiplexing equipment for giving at a central control point a continuous indication of the operation of apparatus situated in remote locations. Initially designed for monitoring airfield control lights, the equipment can be used to relay signals along wires up to five miles in length, and a single pair of wires is sufficient to convey information from up to twelve sources.

Mr. Bruce Wilkinson, formerly managing director of Electronic Tubes, Ltd., who has joined the Plessey Co., Ltd., as manager of their Swindon components division. Mr. Wilkinson, a graduate of Sydney University and with experience of industrial management both in Australia and the U.K., came to England in 1946 as commercial manager for E.M.I., Ltd.

A photograph of the Comet "3½A" secured by "Flight's" photographer on Monday of this week. In the hands of John Cunningham, D.H. chief test pilot, it was making its first flight after an extensive six-month refit. It will now undergo flight trials for certification —by A.R.B. and C.A.A.—of the Comet 4 and 4A. It is due to be joined by the first true production Comet 4 in the autumn.

CIVIL AVIATION

THIS WEEK'S VISCOUNT ORDER

IT was announced earlier this week that Black Lion Aviation, Ltd., have placed an order for one Viscount 810, for delivery early in 1959. Black Lion Aviation is a new company being formed by Mr. B. M. Mavroleon, chairman of London and Overseas Freighters, Ltd. The aircraft has been bought primarily for transporting ships' crews on behalf of the various shipping companies in which Mr. Mavroleon is interested.

The total number of Viscounts now delivered or ordered is 364.

THE CASE FOR THE ELAND-CONVAIR

"BY installing British turbine propeller engines in place of the present piston engines now used in nearly 300 American-built Convair aircraft, many airlines throughout the world would be able to more than double the annual profit of each airliner." This was stated in Yeovil on February 21 by Mr. H. Sammons, managing director of D. Napier and Son, Ltd., when he gave the second Henson and Stringfellow Memorial Lecture before the Royal Aeronautical Society.

Mr. Sammons said that by putting Napier Eland engines in a Convair airliner which flew 3,000 hours a year on journeys of 200 miles, each aircraft would make a profit of £59,400 instead of £23,520. If the aircraft were operating on flights of 800 miles the additional profit per aircraft would be £51,780. "The extra profit made on a fleet of 20 machines would," he said, "be over £1,000,000 per year." A similar result would be obtained by re-engining at least two other types of American airliners—the DC-6B and the Lockheed Constellation 749.

A PEER'S CRITICISM

ON February 21, in the House of Lords, Lord Morris referred to delays on Aquila's Solent service to Madeira, and spoke of a "shack at Genoa which could not be called an air building" and said that "this sort of thing might well mean mass homicide."

In a formal statement issued afterwards, Aquila said that they would be glad if Lord Morris would repeat these observations outside the House of Lords, adding that he was the only passenger whose taste had been offended by the "contemporary-style stone building erected by the authorities at Genoa." The company had operated services for eight years, during which time not a single passenger had received injury. During the past winter months Aquila had been suffering serious delays due to "unprecedented continuous winds," although they had taken full responsibility for these delays, as did other companies whose services were delayed by weather. Since the weather had improved, the flying-boat services to Madeira had been operating to schedule.

HONG KONG'S NEW AIRPORT

THE planning and design of Hong Kong's new airport was the subject of a paper read before the Institution of Civil Engineers (Airport Engineering Division) on February 26 by Mr. H. Grace and Mr. J. K. M. Henry, partners in the firm of Scott and Wilson, Kirkpatrick and Partners of London. We give below a brief synopsis of this detailed and valuable paper.

Planning the new airport was complicated and largely determined by the mountainous topography of the colony, and the high demand for any existing flat land. The plans ultimately adopted are for a single-runway layout on land to be reclaimed as a promontory extending out into part of the harbour.

One approach will be a straight instrument-approach from the sea, but the other involves a 40 deg turn to avoid mountains. The runway will be 8,340ft long, but because of high buildings on the north-west approach, 1,140ft will not be used for landing on this approach. The airport is planned to take the new large jet airliners, and the pavements, which will be flexible, will be designed for 160,000 lb on one dual-tandem undercarriage or 60,000 lb on one wheel, with a tyre pressure of 250 lb/sq in in each case.

POLISH RE-EQUIPMENT

THE Polish airline LOT is negotiating for the purchase of a fleet of Convair 240s, reports the Polish journal *Skrzydlata Polska*. The airline intends, according to this source, to put into service by 1958 "turboprop airliners of Iluyshin or Antonov design." These aircraft, it is stated, will carry 60-70 passengers, and a total payload of about 26,500 lb at a cruising speed of 340 m.p.h. (445 m.p.h. maximum). Still-air range is said to be 3,100 miles.

Polish airport facilities are to be considerably improved and, to increase passenger appeal, "special attention" is being paid to the internal and external finish of aircraft. Warsaw airport is to be equipped with "a complete system of radar navigational aids" of Polish design and manufacture before the end of this year; other airports will follow suit.

A Viscount picture with a particular significance. It shows the sixtieth and last aircraft of the original Capital order on test with six weeks in hand before expiry of the contract delivery date. Capital's repeat-order for 15 more is also ahead of schedule.

A Tu-104 is seen here at Irkutsk Airport, second stop on the new regular Aeroflot service between Moscow and Peking—a service which connects with Prague. Note overwing refuelling, and the 11-14

CIVIL AVIATION . . .

CONVAIR 880s FOR ARGENTINA

ON November 9 last we foreshadowed an order for four Convair 880s from California Eastern Aviation Inc. of Washington. This organization had, a short time before, completed an aircraft "lease-purchase" arrangement with the newly certificated private Argentine airline Transcontinental, S.A., of Buenos Aires. The airline has recently received permission from the C.A.B. to operate services from Buenos Aires to New York and to San Francisco, and now confirm their order for four Convair 880s, which will be used on both these routes—*via* intermediate stops which have not so far been announced.

This is the first export order to be secured by Convair for their medium jet airliner, 30 of which have been ordered by T.W.A. and 10 by Delta.

An American source recently reported an imminent "major sales break-through" for the Convair 880. South American, European and U.S. airlines were suggested for new orders.

Transcontinental S.A., is 75 per cent owned by private Argentine capital, and 25 per cent owned by California Eastern. The latter company is not a certificated airline—although it hopes to be one soon: its interests comprise cargo and passenger charter work for the U.S.A.F. and U.S. Navy; primary flying training at Moore Air Base, Texas, for the U.S.A.F.; engineering and manufacturing activities, also largely for the U.S.A.F.; and sales and purchasing activities on behalf of U.S. manufacturers and foreign buyers. It is in the last context that they are, presumably, participating in the Argentine purchase of 880s.

Although military T56 versions of the Electra's Allison 501 D-13s have been flying in "Old 1961" (the Constellation prototype), only recently has the first true civil engine been installed in that aircraft. The installation is seen here in progress at Burbank. Electra design-work is now virtually completed, and production parts are being completed at a rate of 1,000 per week.

GOLD BLOCK SPEEDS

ON page 284 we review the S.B.A.C.'s third display of weight control, held at the Seymour Hall, London, from February 14 to 20. The importance of weight control in transport aircraft design needs little emphasis; and one aspect of the display, on which we do not comment in our review, is of obvious interest to readers of these civil aviation pages.

It has been calculated in the past—probably spuriously and with more regard for effect than accuracy—that airframe weight saved is worth its own weight in gold. A recent, analytical approach with stated assumptions by the S.B.A.C. Technical Section shows that the value to the air-transport operator per lb of weight saved is roughly proportional to block speed, and that long-haul block speeds in the 1960s will raise this per lb weight value to something approaching half the cost of a lb of gold *per annum*. Weight saving, particularly in detail design, costs money; but, the S.B.A.C. conclude, it is safe to say that to save one lb of weight it is worthwhile spending £35.

MR. BASIL SMALLPEICE

FOLLOWING an operation in London, Mr. Basil Smallpeice is not expected to resume his duties with B.O.A.C. for several weeks. This was announced last week by Sir George Cribbett, the Corporation's deputy chairman. (Mr. Gerard d'Erlanger, the chairman, is overseas). While Mr. Smallpeice is absent, Mr. Keith Granville will deputise for him and will continue his own duties as commercial director. He will carry the full executive authority and responsibility attaching to the post of managing director.

AIRLINE FOR GHANA?

AN official announcement in Accra last week indicated that Ghana intends to establish its own airline when it gains Commonwealth status on March 6. It is intended that the new airline should operate both domestic and international services for the Gold Coast, probably including flights to London—a prospect also reported to be under consideration by West African Airways Corporation.

Until the formation of their own airline, the Gold Coast Government and the governments of Nigeria, Sierra Leone and Gambia will continue their participation in West African Airways. The names of Elder-Depster and Hunting-Clan have both been connected with reports of the formation and operation of an airline for Ghana, although it is understood that no offer has as yet been made by either company.

OLD SORES, SOOTHING OIL

ON these pages last week we reflected upon the difficulties which Hunting-Clan have encountered in attempting to introduce Viscounts on to their colonial-coach services. Shortly after our comment was written the problem was aired in the House of Commons. It was stated that the company's idle Viscounts represent a liability of £200 a week each, and the Minister of Transport and Civil Aviation was formally asked if he would allow Hunting-Clan to substitute them for their outmoded Vikings on the African routes.

Mr. Harold Watkinson replied that the colonial-coach services were designed to create a new class of cheap travel appropriate for oldet-type aircraft and reserved for independent operators. He was, he said, reviewing the basis of these services to ensure that "operators continue to have opportunities for development appropriate to present-day changing conditions". And to assist him he had asked the Air Transport Advisory Council for its advice "as a matter of urgency"—a decision which he felt to be the right one in view of the likely introduction of third-class high-density fares which would change the whole pattern of the fare structure. Meanwhile, negotiations for the sale of Hunting-Clan's two Viscounts continue.

Southern Rhodesia now has an airport to match the Federation's bustling commerce and prosperity. Here—in a photograph by "Holiday and Travel Magazine," Salisbury—is the new terminal building at Salisbury, the opening of which is referred to below.

SALISBURY'S NEW AIRPORT

SALISBURY Airport's new £400,000 terminal building was officially opened on February 5, six months after the airport was first used by airline traffic. During those six months, Salisbury has been the busiest African airport south of the Equator.

There are an average of about 120 arrivals and departures during the hours of daylight. Since July 1956 133,816 passengers and 10,225 civil aircraft have passed through, and in the peak period —June and July—20,000 passengers a month are expected—5,000 more than through Jan Smuts, Johannesburg. Scheduled airlines which are at present using the airport are B.O.A.C., S.A.A., U.A.T., Central African Airways, Hunting-Clan, Airwork and D.E.T.A. (the Mozambique airline) and Alitalia are expected to operate through the airport later this month.

Airline staff, who for the past six months have been obliged to process passengers in a hangar converted into temporary traffic offices and freight sheds, now have capacious offices in the new terminal building. Passengers and public have the benefit of well-appointed lounges, a cocktail bar and restaurant, and a terrace on the first floor from which they can watch arrivals and departures. The controllers are particularly well catered for; the tower—which is 55ft 6in above the apron—has many specialist features, including pitched glazing (see the *Flight* photograph in our February 1 issue) and a separate air-conditioning plant.

The main 8,612ft runway has excellent approaches and could if required be extended to 14,000ft. Navigational aids are of the most modern type; in addition to V.D.F. and M.F. beacons, Decca 424 aerodrome control radar was installed on February 1. V.O.R. will soon be added to the existing navaids, and will be available for B.O.A.C.'s Britannias, which begin their scheduled flights through Salisbury this month.

COLLISION-WARNING SETBACK

FOLLOWING publication by Collins Radio Inc. of the initial engineering specification for a collision-warning device for civil aircraft (outlined in *Flight*, November 30, 1956) there have been some rather surprising developments. Collins had at that time some 10 million dollars worth of advance orders for the equipment on hand and were working on a frequency-modulated continuous-wave radio using Döppler effect, while both Bendix and Hughes —other competitors for the supply of proximity-warning indicators to the eager civil market—were working on pulse radar systems.

At the end of 1956 it began to be apparent that certain problems might prove insurmountable. Bendix had already called attention to these when Collins announced that their own approach was not feasible and that they would have to follow a different line of approach; they even went so far as to release their prospective customers from all commitments. Hughes soon afterwards reached the same conclusions and stopped work on their system in January.

The trend of opinion seems to be to base all hopes of collision warning over the U.S.A. on the tremendous A.T.C. radar coverage planned for completion during the present three-year expansion programme. Nevertheless, the A.T.A. may now ask for the development of a better non-co-operative proximity-warning indicator based on the original stage 1 specification and, secondly, a co-operative system with provision for automatic collision avoidance. (A non-co-operative system is one that enables an aircraft to spot other aircraft whether they carried collision warning or not.)

The serious doubts about the possibilities of operating the now-abandoned P.W.I.s were the result of ground clutter below 10,000ft. This particularly affected Collins F.M./C.W. Another difficulty was turbulence which upset the sensing of the Döppler effect and prevented positive identification of collision risk in a significant fraction of cases. Pulse Döppler could overcome ground clutter, but an adequate system would at present be too expensive, heavy and complex; P.W.I. aerial systems might weigh up to 100 lb.

The U.S.A.F. are also interested in a P.W.I., but they require operation at closing speeds of about Mach 4 and for this a co-operative system is imperative. In any case, one of the major problems with this type of equipment is to achieve a universal coverage, and it is estimated that some five or ten years will elapse before 50 per cent of all aircraft are equipped, thus offering a reasonable degree of collision protection.

Seen at New Delhi after inspecting a B.O.A.C. Britannia, which was on a proving flight to Sydney, are Mr. A. K. Chanda, Comptroller and Auditor-General of India, and Air Marshal S. Mukerjee, O.B.E., I.A.F. Chief of Air Staff.

YORK MALTA ACCIDENT QUERIES

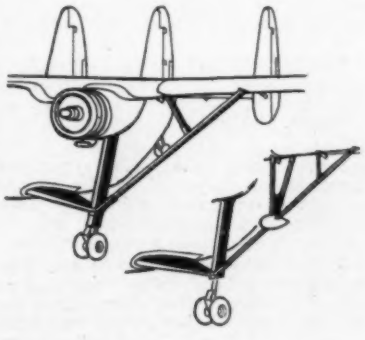
THE committee of inquiry set up to investigate the accident to York G-ANSY in Malta last February attributed the cause to an error of judgment by the pilot, who—with all the passengers and crew—perished in the crash. The port outer engine failed soon after take-off from Luqa in gusty weather, and the pilot was unable to clear the high ground on the track being flown.

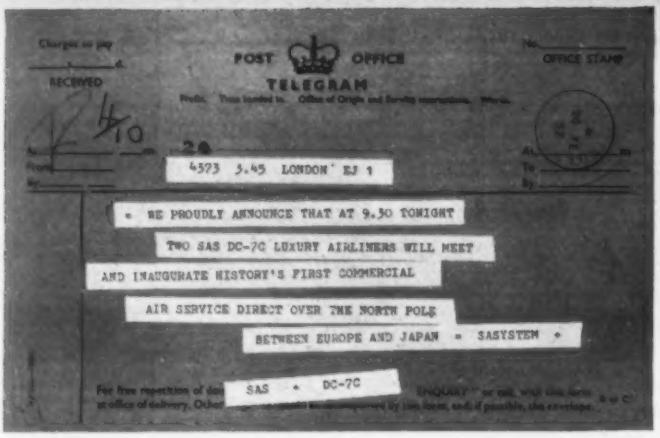
Various aspects of the inquiry, and the performance of the York under the conditions prevailing (it was pointed out that the aircraft had seen considerable service) have been questioned by the British Air Line Pilots' Association, who have expressed themselves dissatisfied with the judgment of the committee.

They ask in particular "How was the Court so sure that the propeller feathering mechanism of No. 1 engine functioned correctly?" . . . "Would the aircraft have been capable of three-engined performance if No. 1 propeller had not been feathered?" . . . "Was it correct to say that the boost gauge should have indicated *conclusively* that no power was being derived from this engine?"

The Association have some doubts that the York, under the conditions prevailing at Malta, would have shown a satisfactory performance on three engines, and they hold that the possibilities of propeller malfunctioning (the propeller was found by the accident investigators to be unfeathered) had been glossed over. They cited a known case of inexplicable malfunctioning of a similar feathering installation and another case where a defective

Recent photographs of the Twin Pioneer reveal marked simplification of the wing-to-undercarriage attachment struts. In these self-explanatory sketches the old arrangement is shown beneath the new one. Weight remains the same, but drag has been reduced.





POST OFFICE TELEGRAM

OFFICE STAMP

4573 3.45 LONDON EJ 1

= BE PROUDLY ANNOUNCE THAT AT 9.30 TONIGHT TWO SAS DC-7C LUXURY AIRLINERS WILL MEET AND INAUGURATE HISTORY'S FIRST COMMERCIAL AIR SERVICE DIRECT OVER THE NORTH POLE BETWEEN EUROPE AND JAPAN = SASYSTEM =

SAS = DC-7C

ENQUIRY" or call, will you have

Few inaugural flights have received more publicity than did the opening last Monday of the new S.A.S. service between Europe and Japan. On the left is the telegram "Flight" received from S.A.S., and on the right is Captain A. Hedall-Hansen, 52, the veteran Danish captain of the DC-7C which flew from Copenhagen to meet, over the North Pole, a sister aircraft from Tokyo.

CIVIL AVIATION . . .

engine on a York had in fact shown 4 lb boost and 2,400 r.p.m.

On a first reading the grounds for B.A.L.P.A.'s dispute may appear to hang upon remote probabilities; but nevertheless the Association obviously wish to avoid members being blamed for pilot error if, in their view, any shred of evidence is circumstantial or conjectural.

SHORT SHRIFT FOR THE JET TRANSPORT

STRONG words in favour of turboprops characterized the speech by Mr. Frank Robertson, Short's chief project designer, at the Institute of Transport dinner at Belfast Castle on February 21. We have already recorded his company's design philosophy for an all-purpose turboprop transport (see February 22 issue); although this project has not materialized, and the company has announced no plans for a new civil aircraft, the following words indicate the present views of this traditionally commercial-transport manufacturer:

"There are some who say," Mr. Robertson remarked, "that the turbojet is as cheap, or very nearly as cheap, to operate as the turboprop. It is true that the gap can be made to look small by juggling with load factors and utilizations; but the crux of the matter is that, to carry the same number of people from London to New York, the turbojet aircraft weighs half as much again as the turboprop, requires half as much again in runway length, and has to carry twice the amount of fuel, to say nothing of making a frightful noise. In return for these debit items, it offers a journey time of six and three-quarter hours against seven and three-quarters.

"I am not a reactionary who does not want to go fast. I think that there should always be a few aircraft on the North Atlantic capable of going very fast indeed for those whose time is very valuable. I also believe that, where increased speed shows a hope of reduced costs, then it should be adopted. My grouse is that the world's airlines are tending to rush downhill after the big U.S. jet transports without giving sufficient thought to the possibility of getting much lower fares and, therefore, greatly increased traffic by the means of turboprops.

"This vicious trend which—if it is allowed to continue—could easily prevent world air traffic from quadrupling itself, must be fought by all socially-minded people. We want to be able to fly around the world at prices we can afford. The converted jet bomber is not the aircraft for the job. Our air leaders must be made to see that international fare agreements designed to suit the U.S.A. must be fought tooth and nail. We must be allowed to develop our lead in the turboprop field and to introduce cheaper fares."

I.C.A.O.'s NEW PRESIDENT

ON February 20, after Sir Frederick Tymms had stood down as a candidate for the presidency of I.C.A.O., the council elected Mr. Walter Binaghi of Argentina to succeed the retiring president, Dr. Edward Warner of the U.S.A.

Mr. Binaghi, who is 37, graduated from Buenos Aires University as a civil engineer, later becoming a member of the Argentinian Ministry of Aeronautics. His association with I.C.A.O. began in 1947; in addition to serving as his country's representative, he has been chairman of the I.C.A.O. Air Navigation commission since 1949. In June 1954 he was elected president of the eighth session of the I.C.A.O. assembly in Montreal. Mr. Binaghi's term as president of the I.C.A.O. council (which was elected in Caracas last year) extends until 1959, when the I.C.A.O. Assembly is due to elect a new council.

BREVITIES

IT is understood that Braathens S.A.F.E. Airtransport of Oslo have purchased a Lockheed Electra. The Loftleidir Icelandic Airways' order for two Electras—foreshadowed last week—is now confirmed. The Braathens company is associated with Loftleidir in the latter's North Atlantic services.

* * *

An Australian broadcast reported last week that T.A.A. were interested in the Caravelle, following a visit there of Sud-Est's M. Jean Gelos.

* * *

Two T.W.A. management specialists are to study Air-India's operations and accounting and administration methods, under the terms of a contract recently signed between the two airlines.

* * *

The Canadian Government is arranging to charter aircraft to carry British emigrants to Canada, supplementing the normal scheduled services. About 30,000 emigrants are expected in 1957.

* * *

Both B.O.A.C. and PanAm are reported to have been separately discussing with Central African Airways the future activities of that company. Hunting-Clan's interest in C.A.A. was recorded last week. C.A.A. lost about £250,000 last year.

* * *

By reshuffling KC-135 military tanker production, Boeing are contemplating delivery of the first commercial 707s two months earlier than the announced date. (PanAm's first aircraft were due for delivery in December 1958.)

* * *

El Al, who are due to receive their first Britannia on May 14, are reported to be planning to start transatlantic services in July, at an initial rate of three round trips a week. B.O.A.C. have not yet announced the date for the introduction of their Britannias on the Atlantic route: they also take delivery in May.

Mr. Sayid Askari has been appointed manager of Iraqi Airways.

* * *

Nairobi's new international airport at Embakasi is expected to be ready for service in March 1958, to replace Eastleigh.

* * *

T.W.A.'s Lockheed L.1649As have been officially named Jet Stream Starliners. They will be introduced in July.

* * *

C.P.A.L. have been granted permission by the Canadian Government to fly a scheduled service between Montreal and Lisbon with, later, an extension to Madrid.

* * *

In the next five years Frankfurt Airport main runway will be extended to 9,840ft with an additional 1,000ft stopping strip. Further extensions will be made later if necessary.

* * *

Mr. Noel Capper, Scottish Aviation's chief test pilot, said in America recently that there was a possibility that the Twin Pioneer would be made in the U.S. under licence.

* * *

Sabena last year made a profit of 78 million Belgian francs (£540,000). The airline announce that, subject to approval, they will start a twice weekly service to Budapest and Bucharest.

* * *

Three more U.S. airlines have stated their intention to apply for a six per cent fare increase, following the recent United and Capital moves in this direction. They are T.W.A., Delta and Continental.

* * *

In a B.B.C. television programme on February 20, Sir Roy Dobson said that two specifications for British supersonic airliners may be drawn up, one designed to fly at about 800 m.p.h. [Mach 1.2] and the other at about 1,200 m.p.h. [Mach 1.8]. He said that "seven leading aircraft firms" would compete for orders.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

Standard Presentation

HER MAJESTY THE QUEEN is to present a Standard to No. 43 Squadron at R.A.F. Leuchars on Tuesday, June 4. The squadron hopes to see former members at the ceremony, and those wishing to attend should communicate as soon as possible with the Adjutant, No. 43 Squadron, Royal Air Force, Leuchars, Fife.

City of London Farewell

QUEEN Elizabeth the Queen Mother is to take the salute at the farewell parade of No. 600 (City of London) Sqn., R.Aux.A.F., and No. 2600 (City of London) Sqn., R.Aux.A.F. Regiment, at Finsbury Barracks on Sunday, March 10. Afterwards the Queen Mother, who is honorary air commodore of both squadrons, will attend the laying-up of the No. 600 Sqn. Standard in St. Bartholomew the Great, Smithfield.

A.D.C. Appointment

THE appointment of Air Marshal Sir Claude Pelly, K.C.B., C.B.E., M.C., as Air Aide-de-Camp to the Queen, with effect from January 29, was announced in the *London Gazette* last week. He succeeds Air Chief Marshal Sir Francis J. Fogarty, G.B.E., K.C.B., D.F.C., A.F.C., on the latter's retirement from the R.A.F.

Air Marshal Pelly has been Controller of Aircraft at the Ministry of Supply since November last year, having previously been Commander-in-Chief, Middle East Air Force, from October 1953. From December 1951 until going to the Middle East he was R.A.F. Instructor at the Imperial Defence College.

No. 100 Sqn. Birthday

ONE of the most famous R.A.F. bomber squadrons—No. 100, now based at Wittering, Northants, and equipped with Canberras—celebrated its 40th birthday on February 23. Formed in 1917, nearly a year before the R.A.F. itself came into being, No. 100 was the first specialized night bomber squadron in the R.F.C. Originally flying F.E.2Bs, it was re-equipped towards the end of the war with Handley Page O/400s. When the last war started the squadron was based at Singapore, flying torpedo bombers, and during the Japanese invasion was virtually wiped out. In 1942 it reformed as a Lancaster squadron and it has remained in Bomber Command ever since. The present commander is S/L. R. A. McPhie.

No. 100 Squadron [a history of which was published in *Flight* for October 28, 1955] is probably unique in having had three different mottoes during its existence. The first was "Blood and Brains"; the second, *Nemo me impune lacessit* ("None provokes me with impunity"), was acquired at Donibristle, Scotland, in the 1930s; while its present badge was given to the squadron at Singapore in 1938, with the Malay motto *Sarang tebuan jangan dijolok* ("Do not poke a hornet's nest").

Movements School Extension

ON February 21, A.V-M. L. W. Cannon, Director-General of Organization, Air Ministry, opened new technical accommodation at the R.A.F. Movements School, Kidbrooke, London, S.E.3, and after the ceremony presented to the commanding officer (S/L. L. H. Clint) the original painting of the school badge, produced by the College of Arms and signed by H.M. the Queen. The school was founded in 1954 and its badge bears the motto *Ars lenit iter* ("Skill smooths the journey").

Ski-ing Champions

AT Zermatt, Switzerland, on February 20, the 1957 R.A.F. ski championship was won by F/L. Zenon Kaye of Fighter Command. F/O. Nicholas Galpin (Flying Training Command) was second and Cpl. Rudolph Prochazka (R.A.F. College, Cranwell) third.

Battle of Britain Week

THIS year Battle of Britain Week will be from Monday, September 9, to Sunday, September 15; and by decision of the Air Council, September 15 has been fixed as Battle of Britain day. As this is a Sunday it will be made the occasion for ceremonial parades which will include religious services. On Saturday, September 14, a number of R.A.F. stations will be "at home."

Pilots of No. 1913 Light Liaison Flight after landing their Austers at R.A.F. Station Aldergrove, N.I., last week to assist in defence against I.R.A. operations. Left to right: Capt. P. Wilson, D.F.C., commanding officer (the unit is under Army operational control); S/Sgt. R. Meaton, Sgt. R. Adamson; Sgt. T. Davies and S/Sgt. R. Hall.

P/O. Judith Church, as the best officer cadet, receives the sash of merit from G/O. Jean Conan-Doyle at last week's passing-out parade at No. 41 W.R.A.F. Officer Training Unit, Hawkinge, Kent.

R.A.A.F. Reserves

IN Brisbane last week Air Marshal Sir John McCauley, retiring C.A.S. of the R.A.A.F., said it would be "ruinous" for Australia to follow Britain's lead in dispersing its reserve air force units. These still had a real part to carry out in Australia's defence, and piloted aircraft would remain a major factor in R.A.A.F. planning for many years to come—though it was aware of the vital defence contributions made by guided weapons, and was playing a big part in their development by helping to maintain missile-testing areas.

No. 603 Squadron's Farewell

IN Edinburgh on February 17, No. 603 (City of Edinburgh) Sqn., R.Aux.A.F.—which was formed in 1925 and in the last war had the distinction of destroying the first enemy aircraft over this country—held its final parade when the squadron Standard was laid up in St. Giles' Cathedral. Sir John Banks, the Lord Provost, took the salute at the Mound as the squadron, headed by its pipes and drums, marched to the cathedral. During the service, lessons were read by the Earl of Selkirk, First Lord of the Admiralty and a former commanding officer of No. 603, and by the present C.O., S/L. M. E. Hobson.

Antarctic Air Operations

AIR reconnaissance operations by the R.A.F. detachment with the British Transantarctic Expedition, carrying out the twofold objective of helping the main party to find a way through pack ice to the expedition's base at Shackleton (on Vahsel Bay in the Weddell Sea) and of preparing for the crossing of the polar plateau, have been described in messages from S/L. John Lewis, A.F.C., the detachment's commanding officer.

A total of 55 hours' flying has been achieved by the pilots, S/L. Lewis and F/L. Gordon Haslop, in the Otter (which has been flown for 37 hours, taking off and landing on skis) and the Auster (18 hours, 8 from water using floats), the two aircraft with which the detachment is equipped.

S/L. Lewis reported recently in a signal to Air Ministry that all preliminary reconnaissance flights had been completed and that "depot laying" (the establishment of Depot 300, the expedition's post 300 miles south of Shackleton) was to begin shortly.

SERVICE AVIATION . . .

He said he estimated that a further 15 sorties were required to fly-in the 30 tons of stores necessary for building up the depot and preparing for the plateau crossing to link up with the New Zealand group led by Sir Edmund Hillary.

Token of Appreciation

IN token of its appreciation of the training by the U.S. Navy of some 258 Fleet Air Arm pupil pilots, the Admiralty presented a silver trophy replica of a Vampire to the U.S. Naval Air Training Command at Pensacola, Florida, on February 21. The presentation was made by Vice-Admiral R. F. Elkins, C.B., C.V.O., O.B.E., Admiral, British Joint Services Mission, Washington, to Vice-Admiral A. K. Doyle, U.S.N., Chief of U.S. Naval Air Training; and Rear-Admiral C. L. G. Evans, C.B.E., D.S.O., D.S.C., R.N. Flag Officer Flying Training, who was on a visit to the U.S. Navy, was also at the ceremony at Pensacola Naval Air Station.

The trophy (a photograph of which is reproduced on this page) carries the following inscription on its base:

"The Royal Navy Vampire Jet Fighter. A model of the aircraft which landed on H.M.S. 'Ocean' in December 1945 and thus performed the first scheduled jet deck landing in the world. Presented by the Lords Commissioners of the Admiralty in grateful acknowledgement of the assistance rendered by the United States Navy in training British Naval Pilots 1952-1956."

The value of the training, in terms of money, is estimated to be about $20m (£7,150,000); this has been borne by the U.S. Government under the Mutual Defence Assistance Programme.

Senior Appointments

AN Air Ministry announcement says that A. Cdre. E. S. Butler, C.B., O.B.E., is to be A.O.C., Fighter Command, with the acting rank of air vice-marshal, from March. He has been Director of Organization at Air Ministry since November 1953 and before that, as a group captain, was Deputy Director of Organization (1) from January 1953. He joined the R.A.F. in 1925 and served with Bomber Command during the war.

A. Cdre. D. M. T. Macdonald has been appointed Director-General of Personal Services at the Air Ministry with effect from March, with the acting rank of air vice-marshal, succeeding A.V-M. L. T. Pankhurst, who held the post under its former title of Director-General of Personnel. A.V-M. Macdonald was Senior

The silver Vampire trophy (referred to in an adjoining column) presented by the Admiralty to the U.S. Naval Air Training Command.

Air Staff Officer at H.Q. Transport Command from July 1954 and chief instructor of the transport support wing at the School of Land/Air Warfare, R.A.F. Old Sarum, from 1952. Previously he had served in the Middle East where he commanded, in turn, R.A.F. stations Kabrit and Fayid.

R.C.A.F. Appointments

FROM Ottawa it is announced that G/C. D. R. Miller, A.F.C., is to be chief staff officer of the R.C.A.F.'s 5 Air Division, with headquarters at Vancouver. He succeeds G/C. E. A. McNab, O.B.E., D.F.C., who is retiring; and G/C. Miller will be succeeded as commander of R.C.A.F. Station Uplands by W/C. C. H. Mussells, D.S.O., O.B.E., D.F.C., who is being promoted group captain.

R.A.F. Appointments

BELOW is continued a list of R.A.F. appointments recently announced by the Air Ministry:—

W/C. P. F. Weller to H.Q., AFSE for staff duties. W/C. G. A. H. Wright to No. 2 School of Technical Training, for technical duties; W/C. C. N. Foxley-Norris, D.S.O., O.B.E., to H.Q., Fighter Command, for air staff duties (with acting rank of group captain); W/C. W. A. Hammerton to Air Ministry, for duty in the Department of the Air Member for Personnel (with acting rank of group captain); W/C. T. J. Hanlon to Air Ministry, for duty in the Department of the Air Member for Personnel (with acting rank of group captain); W/C. A. W. Heward, O.B.E., D.F.C., A.F.C., to SHAPE, for staff duties (with acting rank of group captain); W/C. W. L. Jones, D.F.C., to H.Q., Bomber Command, for administrative staff duties (with acting rank of group captain); W/C. A. F. Lowe, M.B.E., D.F.C., to H.Q., Fighter Command, for air staff duties (with acting rank of group captain); W/C. A. R. Atkins to the R.A.F. Selection Board, for technical duties; W/C. H. A. Clark, D.S.O., D.F.C., to R.A.F. Leconfield, for administrative duties; W/C. H. M. T. Eversfield to R.A.F. Andover as President of the Standing Courts Martial (Maintenance Command); W/C. J. V. Marshall, D.F.C., to R.A.F. Honington, for administrative duties.

S/L. W. T. H. Sharp to H.Q., Flying Training Command, for administrative staff duties (with the acting rank of wing commander). S/L. F. G. B. Randall to No. 60 M.U., to command (with the acting rank of wing commander); S/L. A. R. Gilding to Air Ministry, for duty in the Department of the Air Member for Supply and Organization (with acting rank of wing commander).

Emblem Procedure

A WHITE fern-leaf, symbolizing the New Zealand national emblem, is to be emblazoned on the red centre of the roundels of all R.N.Z.A.F. aircraft, vehicles and marine craft. This follows the practice recently adopted by other Commonwealth air forces.

Ghana Visitors

FOUR Valiants of No. 207 Sqn. (Bomber Command) and two Comet 2s of No. 216 Sqn. (Transport Command) are visiting the Gold Coast for the Ghana independence celebrations and are to give fly-pasts and demonstrations over Accra and some of the regional capitals. A.V-M. K. B. B. Cross, A.O.C. No. 3 Group, is the force commander and the Valiant detachment is under W/C. D. Haig.

German Motto

FOR the first time German has been used for the motto of an R.A.F. badge. The unit is No. 646 Signals Unit at Obenkirchen and the motto is *Kein Hindernis zu Hoch*—"No obstacle too high." Badges authorized since 1936 are written in any one of 25 different languages, mostly chosen according to the location of the unit or the predominant nationality of its members and including Arabic, Chinese, Chippeway Indian, Gaelic and Icelandic. Others recently approved are those of the Metropolitan Communication Squadron based at Hendon, and R.A.F. Steamer Point, Aden.

Reunions

NOTICE is given of the following forthcoming reunions:—

H.Q. No. 44 Group, Gloucester, and Stations: Ninth reunion dinner (stag party), Friday, March 29. Details from C. A. Riceman, 39 "Riverbank," Staines, Middx.

No. 1 S.F.T.S.(1) Ambala: Tenth annual reunion, Saturday, April 13, at the Chevrons Club, 3 Dorset Square, London, N.W.1. Details from S. Booth, 31 The Highlands, Crouch Hill, London, N.4.

R.N. Seaplane Bases, Port Said and Alexandria (embodying **No. 269 G. R. Squadron**): 35th (all ranks) reunion, Saturday, April 13, at Stewart's Restaurant, 191 Victoria Street, London, S.W.1, at 6 p.m. Hon. secretary, W. C. Schilling, "Selgrove," Kewferry Drive, Northwood, Middx.

All No. 2 Group Units: Officers' reunion dinner at the Park Lane Hotel, London, W.1, on Saturday, May 4. Cost, 22s.; dress, lounge suits. Apply to F/L. J. A. Beattie, "The Rosary," Partridge Green, Sussex.

S/L. Robert W. G. Freer, who commands No. 92 Squadron and led the Hunter F.6s illustrated in "Flight" last week (p. 253) is here seen (left) with three of his pilots who all wear different uniforms. From second left to right, they are Lt. Michael Kennett, R.N. (an F.A.A. pilot attached to the R.A.F.); Capt. Sam T. Dickens (on exchange posting from the U.S.A.F.); and F/O. John Whitehead, R.A.A.F. (also on exchange posting).